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THE POULTRY INDUSTRY OF THAILAND [1]

F. M. Fronda [2]

After many months of observation and study, and towards the end of my first tour of duty in 1952 as FAO-ETAP Expert on Poultry Production in Thailand, I made the following conclusion regarding the poultry industry of the country: "There is not only the opportunity for development of a large and profitable poultry industry in Thailand, but the creation of such an opportunity would have far-reaching effects on other industries, would create new industries, raise employment, increase the availability of food and improve the general health of the people." During that time, the demand for poultry and poultry products far exceeded the supply and the people as a whole were enthusiastically interested in the poultry industry. I also said then that the indications pointed to the fact that the "baby poultry industry" of the country could be developed into one of the country's ranking agricultural industries.

Industry grows

In 1950, Thailand had only about 5,000,000 chickens and 1,500,000 ducks. In 1955, there were already about 47,000,000 chickens and 17,000,000 ducks in the country. Interest in poultry production continued to increase and, since 1956, Thailand has been exporting chicken eggs, both for hatching and for the table. Thus, within a short period of a few years, Thailand's then baby poultry industry has developed into one of the country's leading agricultural industries and can now assume its place proudly among the major agricultural industries of the country.

The highly favorable conditions of the environment, the enthusiasm of the people, and the support that the Government has given the industry have been largely responsible for this unprecedented growth of Thailand's poultry industry. At present, this coun-

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try's position as a leader in this industry in Southeast Asia is assured. To enable Thailand to maintain this lead in the poultry industry in that part of Asia, efforts are being exerted to improve the industry so that it will continue to grow. The people understand that, like other enterprises, the bigger the industry becomes, the more problems will be encountered. What is particularly significant now is that the poultry industry has reached the stage where the people of Thailand believe in it as an income-producing industry. Many people have been drawn into it as their occupation (fig. 1). This, indeed, is an excellent sign that their faith in the country's poultry industry is continuing to increase.

Fig. 1.—A Thai farmer in a northeastern province feeding his farm flock.

Market outlets

Bangkok is the center of the poultry trade in Thailand (fig. 2). A considerable number of poultry for breeding and eggs for hatching are sold in and around the city (fig. 3). Hatcheries with capacities ranging from 10,000 to 50,000 eggs operate practically throughout the year to supply the day-old chicks that are needed. Table poultry and eggs also find an excellent market in Bangkok and other cities and towns in Thailand. At present there is a growing demand for broilers and interest in the production of this class of table fowl is increasing.

The neighboring countries of Thailand are rapidly recognizing the importance of poultry production to the economy of the country

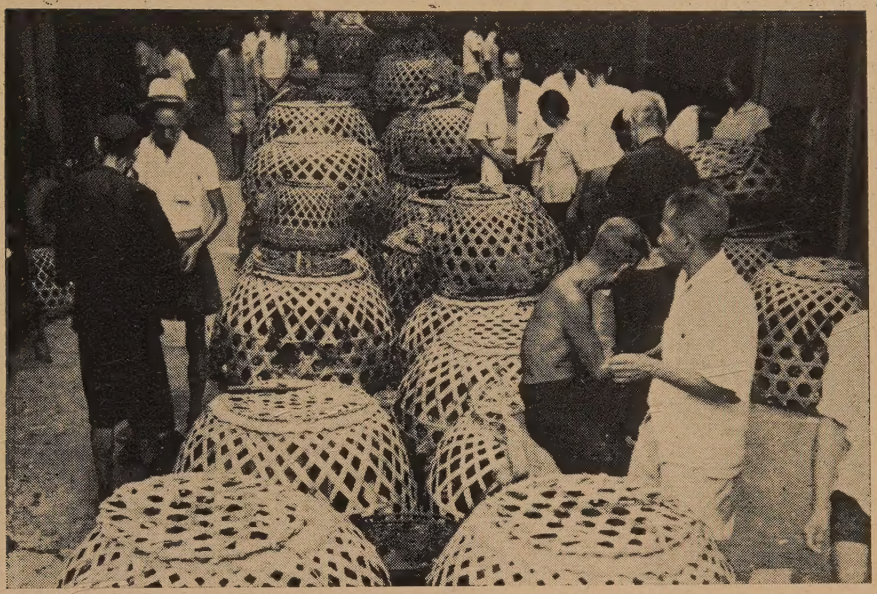

Fig. 2.—The live poultry market in Bangkok, Thailand.

Fig. 3.—Retailing eggs in Bangkok, Thailand.

and in the production of food that is easily within their reach. Proximity to these countries enables Thailand to provide them with fowls for breeding and eggs for hatching. Thus, these countries provide

Thailand with an excellent market for improved breeding fowls and eggs. Large quantities of table eggs are now being exported to Singapore. Other markets are now being considered not only for eggs but also for table poultry, particularly broilers. Last year, several thousand young breeding pullets were exported to Burma, and many thousands of eggs for hatching purposes were also shipped to Laos at the close of the year.

Breeds

The most common standardbred fowls in Thailand are S. C. White Leghorns and Rhode Island Reds. The latter are rapidly gaining in popularity because they have more meat and are as good, if not better producers of eggs than the Leghorns. The following records of the last two years, 1956–1957 and 1957–1958 of the Egg-Laying Contest in Thailand shows the higher average egg production of the Rhode Island Reds.

	CONTEST YEAR	
	1956-1957	1957-1958
Number of birds entered	428	468
Average flock production	216.3	240.5
Average individual egg production		
S.C. White Leghorn	200.8	227.6
Rhode Island Red	223.6	245.3
Barred Plymouth Rock	—	205.5
Highest individual record	324	347
Birds with 300 eggs or over	18	25
Mortality, per cent	8.6	10.7

Agencies aid in growth

The rapid growth of the poultry industry in Thailand was aided greatly by the close cooperation of the various agencies concerned in the industry. Kasetsart University (University of Agriculture) pioneered in raising poultry on a commercial scale and demonstrated to the public that chickens, if properly housed, given the right feeds, and managed well to keep them healthy and strong, could be raised profitably on a commercial scale. The Department of Livestock Development helped in the protection of the fowls against the ravages of diseases and parasites. The Poultry Promotion Association of Thailand has kept the interest of the people in the industry and by sponsoring the Egg-Laying Contest of Thailand, now in its fifteenth year. And, lastly, the Food and Agriculture Organization of the United Nations assigned in the country specialists who helped solve

problems in different phases of the industry. From 1951 to 1957, a poultry disease expert helped in the production of vaccines against the much dreaded newcastle disease and fowl pox, and paved the way towards the gradual eradication of pullorum from the flocks of Thailand. From 1951 to 1952, and again from 1956 to 1958, a poultry production expert was assigned in Thailand to help along educational, breeding and management lines.

Improving the industry further

Managing the flock properly. Like in the Philippines, there is still need for information on the proper way to manage a flock of chickens. Several methods are being employed, the aim being to reach as many interested parties as possible with the minimum of expense. There are now two monthly magazines devoted entirely to poultry raising, both of them popular and of wide circulation in the country. Public lectures on different phases of poultry production are delivered, and short courses on poultry raising are given in Kasetsart University in the Summer Institute held yearly in April, and in other places in the provinces. Lectures which are most welcome and are highly appreciated are also given to groups of farmers. In these lectures, the question-and-answer period has been very helpful in solving on the spot some of the important problems of the poultry farmers.

Encouraging consumption of poultry and eggs. Efforts are being exerted to increase the consumption of poultry and eggs. Articles intended to educate the people on the food value of poultry and eggs and to encourage them to develop the habit of eating eggs and poultry regularly are published in the poultry magazines, the local daily newspapers, and broadcast over the radio.

In this connection, it is interesting to note that in Bangkok, there is a growing practice, started a few years ago, of "saying it with eggs." Gaily decorated baskets of varying sizes and filled with eggs, from 20 to 100 or even more, are given away during the Christmas and New Year seasons. Many thousands of eggs, in appropriately labelled cartons, are likewise given away. This innovation which has become very popular in Bangkok, is certainly an effective way of encouraging people to develop the habit of eating eggs.

Marketing poultry in various ways. One significant feature of poultry marketing in Thailand and one that encourages the consumption of poultry, both chickens and ducks, is that the bulk of

the poultry that is consumed in the cities and towns is sold as dressed and the consumers may buy either the whole bird or parts of it. In Bangkok, there is a big poultry slaughterhouse in one of the big markets in which thousands of both chickens and ducks are killed, scalded, and dressed every day and distributed for sale in the smaller markets of the city. A visit to these markets will show that the stalls are full of plump dressed fowls that are very cleverly displayed (fig. 4). The great bulk of these fowls are shipped alive from the provinces, either in trucks or by train. In the northern and northeastern provinces of Thailand, barbecued chickens are a common commodity. These are peddled in the streets of the towns, in bus stops, and in the railroad stations.

Fig. 4.—Dressed poultry on display. Blood is sold in the form of "cakes" (lower right corner of the picture).

Conducting more research studies. The field of research in poultry husbandry, however, is hardly touched in Thailand. There is urgent need of personnel in this field. As the industry progresses, more problems will arise, and these must be solved. Feeding studies to reduce the cost of production of both eggs and meat should be undertaken. Breeding studies to improve egg production of the flocks and to produce strains of fowls that will be suited to farm conditions in the country will be very timely. A program to improve the egg yield and the meat quality of the farm fowls is now being put into operation. If this program is properly implemented, it will be one sure way of increasing the income of the villagers because it will enable them to sell more eggs and table fowls of better meat qualities than are at present being produced on the farms. In a few

years, the results of this program will be felt by the people in Bangkok when their supply of table fowls will have better meat qualities than those now obtainable in the markets.

Studies are now being made on artificial insemination. The importance of studies along this line may be better appreciated when it is known that many of the layers in and around Bangkok, as well as in the provinces, are raised in battery-laying cages (figs. 5 & 6). In these studies, it was observed that the pH value of the semen increases as a result of storage, and that liquid egg albumen is a much more effective diluter of the fowl semen than the saline solution and other diluters now being used in other places. It was also observed that the motility of the sperms in stored semen cannot be used as a guide in the fertilizing ability of these sperms. Questions like how long may the quality of liquid albumen diluted semen be maintained under ordinary room conditions, how frequent should the layers be inseminated for the best results, and what advantages, if any, will accrue in pooling the semen of a number of roosters are yet to be answered.

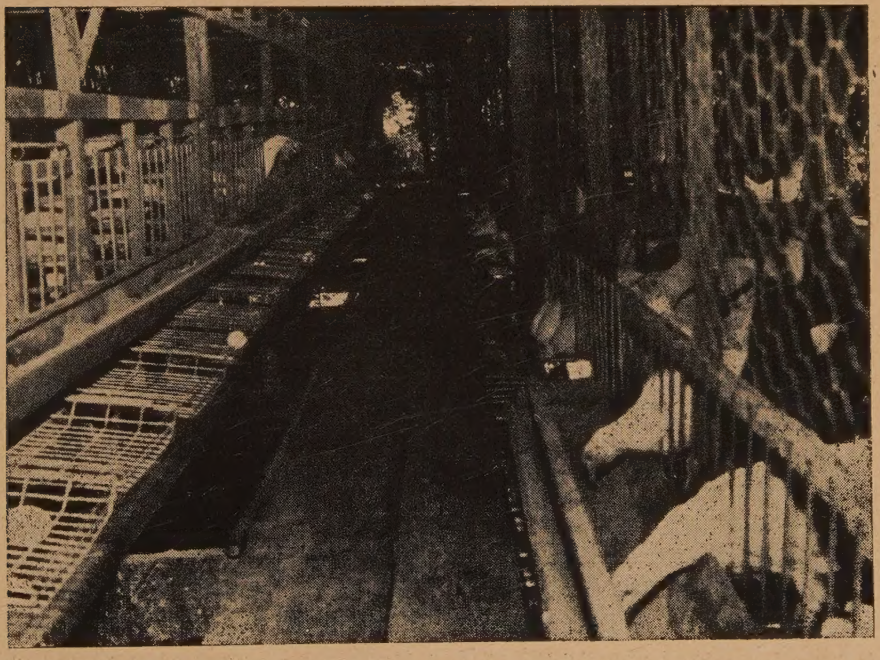

Fig. 5.—In areas that are low and subject to floods, chickens are raised in battery cages that are sometimes two meters high.

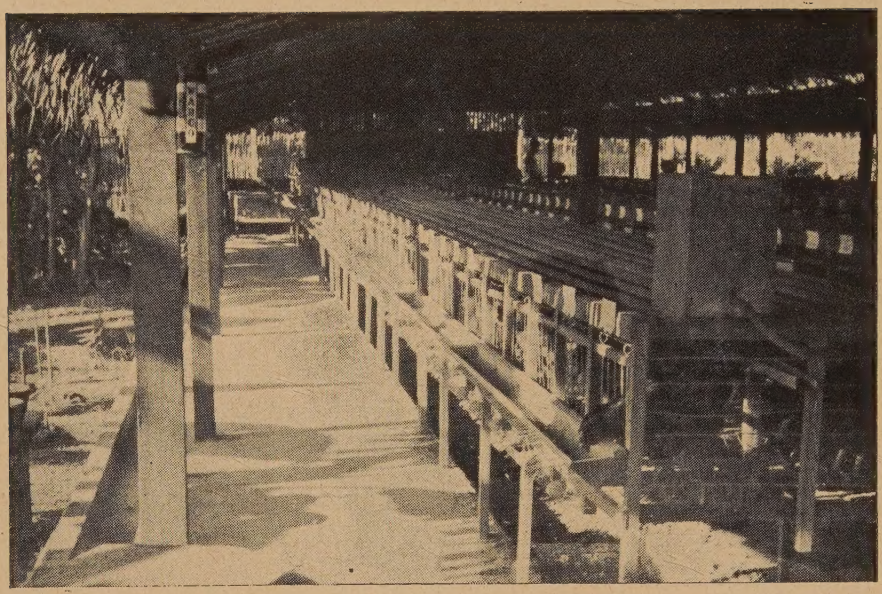

Fig. 6.—Individual laying cages on a poultry farm in a province adjoining Bangkok.

Efforts are now being exerted towards the eradication of pullorum disease from Thailand flocks. Although the poultry raisers of Thailand are rather slow in having their flocks tested for pullorum, they now realize that sooner or later they will have to do this. The demand now is not just for eggs for hatching; these eggs must be produced by pullorum-free flocks. For this reason, in order to increase their trade for breeding eggs, it will be necessary that they have their flocks tested by competent authorities and obtain certificates that their flocks are free from this disease. Kasetsart University has led along this line. The first complete test of the University's flock was made in May, 1957. That time, it was found that 15.55 per cent of the 15,233 layers of the University were reactors. A subsequent test made in July of that year showed that 5.04 per cent were reactors, and the final test that year made in September showed only 1.95 yer cent reactors. In 1958, the entire flock of 16,512 layers was tested for pullorum and 4.45 per cent were found to be reactors. The flock was again tested in September in preparation for the breeding season and only 1.14 per cent were observed to be reactors. The Department of Livestock Development manufactured the antigen that was used in these tests.

Initiating national poultry improvement plan. It has long been felt that Thailand needs a national poultry improvement plan. Such a plan would help insure that only poultry of good laying qualities are propagated for sale to poultry producers and to those who may wish to make a start in poultry farming. The Poultry Promotion Association of Thailand has already taken the necessary steps for the organization of this poultry improvement plan. This plan may take any form, from flock culling and selection, to egg-laying tests and/or record of performance tests and poultry shows. The holding of poultry shows would be necessary to create interest and stimulate enthusiasm of high grade stock only.

Producing own feeds. One advantage that the poultry raisers in Thailand have over their counterparts in this country is that Thailand produces all the ingredients that are essential in their rations. About six years ago, there was not enough corn produced in the country to supply the needs of the poultry raisers. Now, they produce all the corn that they need and with a sufficient amount left for export. Rice bran and *binlid* are plentiful. Poultry raisers are now also beginning to use cassava refuse meal, a waste product obtained in the manufacture of cassava starch of which considerable amounts are produced both to supply the needs of the country and for export. Vegetable oil meals, like soybean oil meal, peanut oil meal, and sesame oil meal, are also produced in sufficient quantities. Fish meal is also locally produced, either from fresh fish or from fish that has been previously salted and then dried. There are a number of commercial feed mixers, all of them making enough money for their efforts and contributing to the growth of the industry. A recent addition to these feed manufacturers is the manufacturer of protein concentrate. This protein premix is rapidly gaining in popularity. It can be shipped easily with instruction on how it can be mixed with either rice bran or ground corn, whichever is easily available in the locality. In this way, the cost of shipping is reduced considerably.

One drawback of the poultry industry in Thailand is the practice of some feed dealers and producers of adulterating the feeds produced in the country. For instance, a sample of fish meal that would normally have about 58 per cent protein was found to contain only about 35 per cent. Similarly, a sample of soybean oil meal that should contain about 42 per cent protein was found to contain only 14 per cent. Rice bran, peanut oil meal, and sesame oil meal, all important ingredients in poultry rations were likewise observed

to be adulterated. Regular periodic analysis of the poultry feeds and the by-products of the different mills now found in Thailand and informing the public of the results would help considerably in reducing this undesirable practice.

Organizing egg-processing corporation. A project that may mean a considerable advantage to the poultry industry of Thailand is the formation of an egg-processing corporation. For this project, both Chinese and Thai capital will be used. Work on this plant was started several months ago and it is hoped that it can begin to operate sometime this year. Thailand poultry raisers will then be assured of a market for all the eggs that they produce. Incidentally, Kasetsart University built a pilot egg powder plant towards the end of 1957, all from the materials that were locally available. It was in operation for a few months after its completion, and will be ready to process any surplus eggs that may be produced. With the present enthusiasm shown by the people towards the poultry industry, Thailand will soon be in a position to export both fresh and powdered eggs.

THE DUCK INDUSTRY

One word about the duck industry of Thailand. Like in the Philippines, this is an old industry in Thailand. The common ducks of the country are very similar to those of the Philippines, and the methods used in their care and management are also very much the same as ours. For its promotion some years ago, the Duck Promotion of Thailand was formed in the Ministry of Interior. To increase the egg production of the local ducks, Khaki Campbell drakes of excellent egg production qualities were used to produce grades. Now, the demand for these grade ducks has gone beyond modest expectations. In most cases, Khaki Campbell-Thailand duck grades are more like the Khaki Campbells in color than the local ducks, and the grades lay more eggs. The duck association recently published a guide for those interested in duck production so that the duck raisers may be gradually shown how ducks may be raised and managed in order to increase the profits obtainable from them. In a province adjoining Bangkok, ducks for meat are produced exclusively by crossing Muscovy with the local ducks, thereby producing "mule ducks." These are very popular in the markets of Bangkok.

To complete this account, I wish to relate the following story that has been repeatedly told by Mr. W. H. Cummings, the Regional

Representative of the Director-General of the Food and Agriculture Organization of the United Nations for Asia and the Far East. According to Mr. Cummings, when he first came to Bangkok ten years ago, pork cost about ten Bahts a kilo, and beef, a little less (one U.S. dollar is equal to about 21 Thailand Bahts.) At that time, chicken eggs that were small and of unknown quality cost from Baht 0.80 to 1.00 each. Now, pork costs Baht 16.00 a kilo, and beef, Baht 14.00. Bigger and better quality of chicken eggs cost the same as these did ten years ago. This story provides a good picture of how the poultry industry has helped the country in its efforts to produce food for the people and to lower the cost of living. It may be added that at the present cost of laying mash, which is Baht 1.40 a kilo, and if eggs are sold at Baht 0.80 each, a flock of layers can break even if it produces only at the rate of 27.1 per cent, i.e., 27.1 eggs from every one hundred layers. A Thailand poultry farmer reported in 1957 that during the last five years that he had been raising chickens, his flock of layers had an average egg production of 53.0 per cent. This shows how profitable a well-managed poultry farm is in Thailand.

AN INTERNATIONAL APPROACH TO PROBLEMS OF RICE PROCESSING [1]

M. MANNI [2] and T. T. HOGAN [3]

WITH SEVEN TEXT FIGURES

III. THE FIRST PILOT RICE MILL IN LIBERIA

An example of FAO's activity in the field of technical advisory assistance is that of the work done between 1952 and 1953 in Liberia, West Africa, in the installation and utilization of a small rice processing pilot plant. In this Negro colony practically all rice is seeded to upland varieties on small plots which are previously cleared of bush by hand during the dry season in January, February, and March and then burned. Seed is broadcast between stumps and logs, and scratched in during the months of May, June, and July. Harvest of early varieties begins in September, with the activities extending through December. Each stalk is cut with a small knife about eight inches below the base of the head, tied into bunches and left to dry in the field among the stumps and logs. Later, these bunches are transported to "kitchens" consisting of a loft in a thatched covered out-building above a smoldering fire where the maturing process is continued. These bunches remain there until they are further processed into home-pounded commercial rice. This storage practice seems to be suitable for current needs and is apparently adequate in maintaining moisture content low enough to minimize deterioration and insect infestation. When needed, the bunches are removed from the loft and threshed by spreading on the ground and flaying with sticks, supplemented by rolling actions of many feet (figs. 1 & 2). In such a procedure small pebbles are inevitably included in the paddy, extraneous material which follows into the commercial product.

With the exception of attempts made several years ago to start operation of small cylinder-type hullers, all processing is done by hand-pounding methods (fig. 3). The equipment for such practices

[1] General Contribution No. 891.
[2] Rural Industries Officer, FAO Headquarters, Rome, Italy.
[3] Expert under FAO's Expanded Technical Assistance Program.

consists of a hollowed-out log and a rounded pole operated by women in a vertical action. Small amounts of paddy are placed in the mortar and then pounded. As the husks are dislodged the mixture is removed and the husked rice and husks separated by means of a fanner, a rigid slightly curved, woven mat-type basket. Any paddy remaining is returned to the mortar for additional pounding. The husked rice is then fit for commercial sale, although the product still contains several per cent of paddy and varying amounts of pebbles. However, before rice is considered suitable for the cooking process it is again pounded by the consumer, during which action the remainink husks are removed, along with additional bran layers. In a subsequent water rinse the stones are picked out.

In Liberia parboiling is not a general practice, the bulk of rice being marketed and consumed in the raw state. However, during the early harvest season when the new grain is high in moisture content both parboiling and parching are resorted to as a means of reducing water content. In parboiling, a small iron pot is partially filled with paddy, and water about one-third the paddy depth is added. Then the top is covered and the pot placed over a fire where it remains until all water has been steamed off. Afterwards, the contents are spread out on bamboo mats exposed to the sun's rays until the grain is considered dry enough for pounding. Parching consists of filling the vessel about one-third full with paddy, and heating over a fire. The contents are agitated by a paddle until fit for processing.

Customarily, paddy is processed on the farms and in the villages before being transported in various quantities to established accumulating centers where traders purchase such offerings by weight on a more or less free-market basis. The traders bag and ship to consuming areas where the rice is either sold or stored in anticipation of advancing prices. As might be expected, prices to producers are lowest during the flush season, gradually rising to a peak during the "famine" period, i.e., in the month of August. During recent years the Government has endeavored to avoid scarcity by storing stocks in Monrovia, subject to withdrawals at the tail end of old crop movement when the normal flow is reduced. Sometimes shortages are not real, inasmuch as paddy supplies in the form of bunches may be quite ample, but due to either a lack of labour, anticipation of advancing prices or the desire to maintain reserves, the producer does not offer home-pounded rice.

One of the reasons against any increase in the size of farms is the practice of cultivating only family-size holdings and hand-pounding the produce. In the past only such quantities which women could conveniently home-pound have been produced. This has kept farms small, either on family or village basis.

Due to these reasons insufficient rice is produced for home needs resulting in eight to 12 thousand tons of rice imported yearly from abroad.

To resolve these problems it seemed reasonable to assume that by erecting a mill to supplement indigenous activities, acreages would be expanded, with the farmers making available for purchase either all or surplus amounts. Also, it was expected that the number of farms would be increased within the accumulating areas.

It was also felt that the recovery of edible rice would be increased by mechanical means as opposed to mortar and pestle practices.

These reasons prompted the Government of the Republic of Liberia to request and obtain from FAO the services of a rice processing expert to advise and assist in the planning and construction, followed by initial milling operations, of a small rice processing pilot plant. The expert served the country from May, 1952, to March, 1954.

Initially the problem resolved itself into three phases: (1) choice of site for pilot plant; (2) selection of equipment; (3) design of structure.

In choosing the site for the mill the following factors were considered: (a) supplies of paddy; (b) transportation; (c) electric power; (d) repair shop; (e) labor; and (f) supervision.

Several locations were investigated, all with certain advantages, but the Government Experiment Station at Suakoko seemed to fulfill most of the important requisites. The Gbarnga district, which includes Suakoko, contains more rice farms than do the Sanakwelle, Tappita and Salala districts. The site borders the main highway and lies south of the road destined to be opened into the western province. On the station adequate electricity is available for mill operations from a Diesel-generator set. A small machine shop which has been functioning on the station should be sufficient for minor repairs of equipment and machinery. Due to a past and present

building program in the Suakoko area a source of unskilled and semi-skilled personnel was assured.

Selection of equipment to fulfill specific Liberian needs was based upon the following points:

(a) Due to the methods employed in threshing, much chaff and dirt and many stones are contained in the paddy. It was deemed necessary to incorporate ample cleaning equipment to eliminate all extraneous materials, with particular attention on stones.

(b) The Liberian preference for rice somewhere between the categories of brown and undermilled stages and current dietary deficiencies make it desirable to conserve as many of the nutrients as possible. For these reasons it was decided to limit scouring to a minimum.

(c) Quality grading standards as generally adopted in many countries are not important in Liberia, so it seemed unnecessary to include other than simple classification. All rice that could be recovered, i.e., heads and chits, were to be packed together.

In view of the rather unique Liberian specifications, it was believed that standard self-contained milling units would not be quite applicable.

On the basis of the above-mentioned points the following units were selected.

Thresher. A hand-powered unit to be placed outside the mill to thresh bunches, thereby speeding up the availability of paddy supplies (fig. 4).

Cleaner. A conventional type, including three-sieve separation and double aspiration, the blast discharging into a cyclone collector.

Stoner. An inclined vibrating deck, based upon airfloat separation through variances in specific weights.

Husk-aspirator. A rubber belt type of husker containing an internal aspirating box connected to an exhaust fan discharging into a cyclone collector, for separation of husks from husked rice.

Scourer. A metal-ribbed cylinder revolving against an adjustable blade whereby the kernels are rubbed against each other. A fan exhausting into a cyclone collector is included.

Fig. 1.—Threshing rice in Equatorial West Africa. Bunches are flayed with sticks;
Fig. 2.—The first threshing operation is supplemented by the rolling action of feet;
Fig. 3.—Mortar, pestle and mat-type basket used in Equatorial West Africa for hand-pounding; and
Fig. 4.—The hand-operated thresher introduced in Liberia by the FAO Expert (Liberian rice pilot mill).

Classifier. A one-sieve vibrating screen clothed with perforated metal.

Logging. Four elevators of metal construction, each 17 feet in height, equipped with high speed cups.

The flow chart indicates the milling process in sequence (fig. 5).

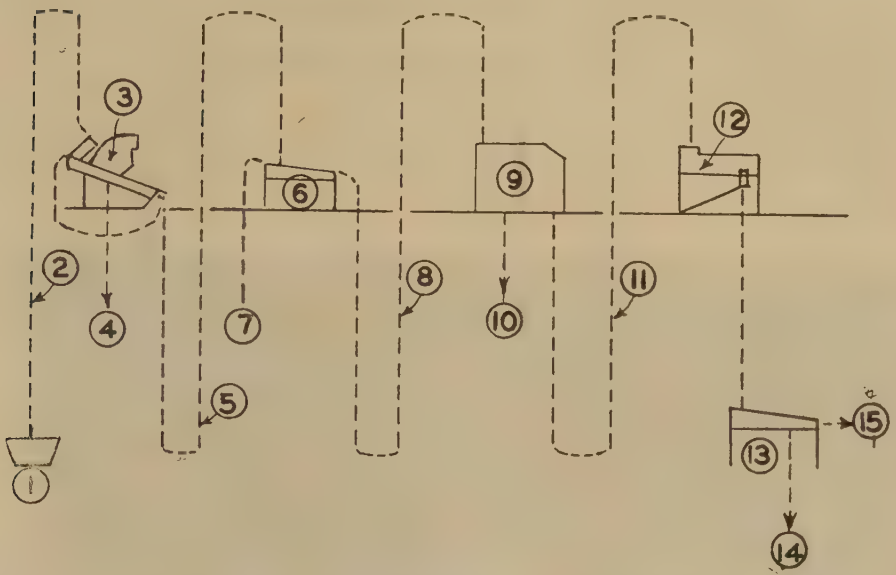

Fig. 5.—Flow-chart indicating the sequence of milling process: (1) Paddy intake; (2) First elevating leg; (3) Paddy cleaner; (4) Refuse outlet; (5) Second elevating leg; (6) Stoner; (7) Stones and metal outlet; (8) Third elevating leg; (9) Husker; (10) Husks outlet; (11) Fourth elevating leg; (12) Scourer; (13) Classifier; (14) Broken grains; (15) Clean rice.

Materials for structure erection were so chosen as to utilize as much as possible those indigenous to the country and yet maintain definite standards.

Total wood construction was ruled out because of conditions associated with tropical climate, e.g., heavy rainfall, probable future insect trouble and high maintenance expenses. Sun-dried clay blocks were believed to be lacking in strength. A combination of reinforced concrete block, wood and asbestos sheeting was decided upon—reinforced concrete floorings and floor slab, concrete-block walls, wooden trusses and roof sheeting.

In designing the layout of the plant, drying facilities were limited to a concrete slab, 50 × 40 feet, which should be sufficient inas-

much as accumulation will necessarily be restricted to paddy with qualities suitable for milling and storage (fig. 6).

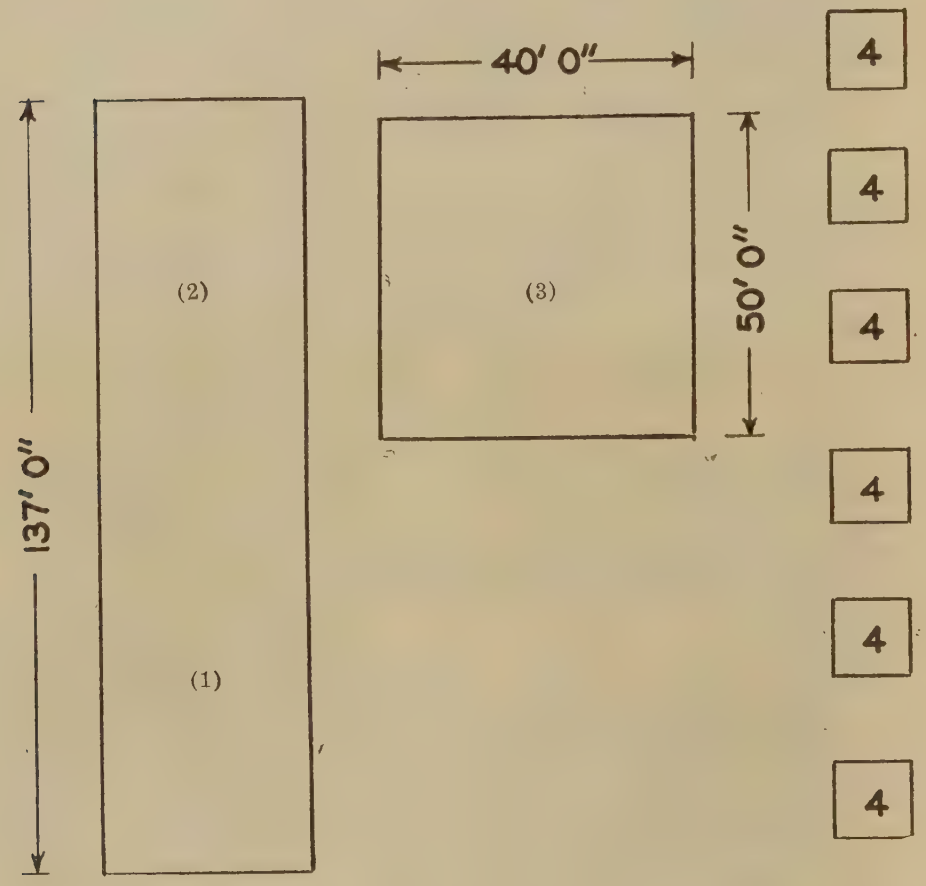

Fig. 6.—Building layout of the Liberia pilot mill: (1) Mill section; (2) Warehouse section; (3) Drying slab; (4) Kitchens for drying and storing of rice in bunches.

Consideration was given to incorporation of bulk storage as compared to sack warehousing. The former has definite advantages but because of the lack of sufficient funds and other factors associated with initiation of the first mill in the country it was deemed advisable to continue the latter method. Supplementary bulk storage may be added in the near future if conditions warrant.

Control of insects by means of insecticides and by the incorporation of vault fumigation was considered but vetoed, on the theory

that sound warehousing practices, including good housekeeping and controlled turnover of stocks, would be sufficient at the initiation of the project.

Erection of the structure was completed in August, 1953 (fig. 7). The shipment of processing equipment arrived in September and was all in the country by October, 1953. Installation of machinery commenced on October 17 and was finished on December 12, 1953. The new power unit was delivered to the station on December 29, 1953, and started functioning on March 24, 1954. Electrical hook-up of motors was completed on March 25, 1954.

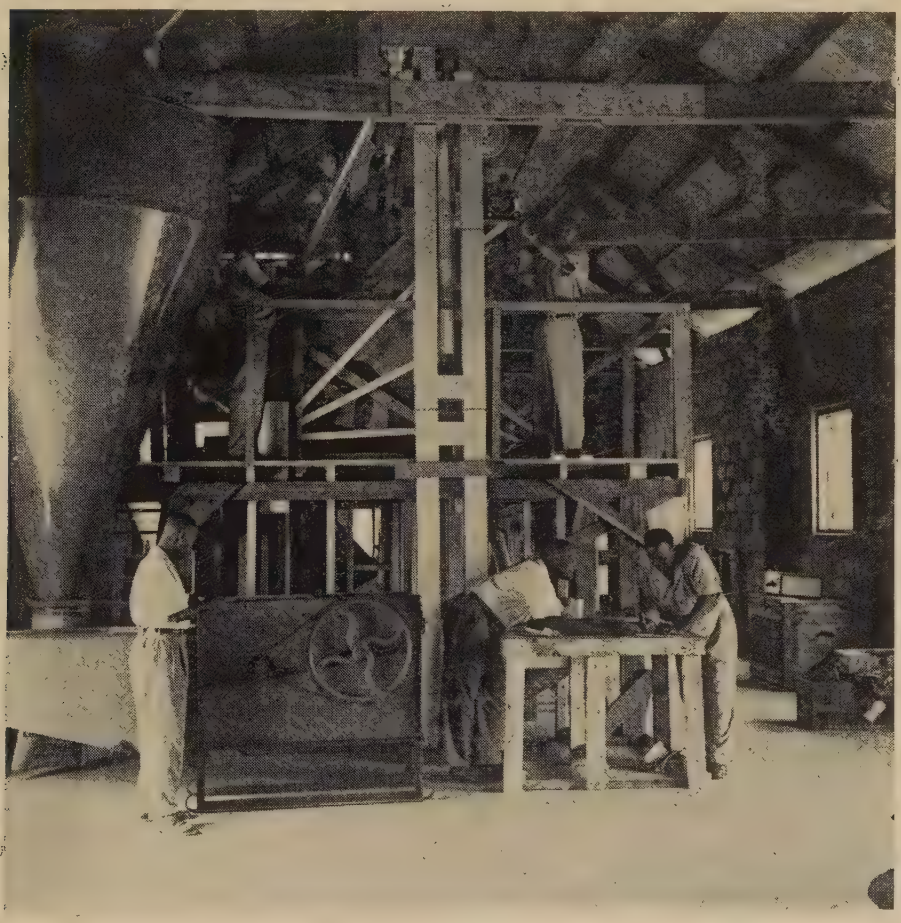

Fig. 7.—Interior view of the Liberia pilot mill.

Initial paddy and bunches of rice deliveries were accepted on December 11, 1953. Activities involving threshing, drying, bagging and stacking in warehouse were inaugurated at once.

As far as organizational side was concerned, two counterparts assigned to the project were appointed to fellowships in Sierra Leone for a 3-month period, from July to October, 1953, where they acquired knowledge in storage, processing and marketing practices as employed in a territory similar in physical and climatic conditions to those prevailing in their own country. One has been appointed to the post of paddy rice buyer; the other will assume the duties of cashier and stock control clerk.

The FAO expert, however, before leaving the country, worked out a number of figures and drafted some notes concerning buying prices, contracts with accumulating agents, trucking rates, selling prices, etc. as a guide to personnel.

Stock control and bookkeeping forms as well as appropriate office management practices were developed and explained to personnel. Daily instructional classes were conducted over a period of six weeks on subject-matter involving both practical and theoretical problems associated with proper milling operation and management.

A SURVEY OF RICE STEM BORER PARASITES IN RIZAL, LAGUNA AND PANGASINAN [1]

MERCEDES D. DELFINADO [2]

Of the 17 species of hymenopterous parasites reared from *Schoenobius incertulas* (Walker), *Chilo suppressalis* (Walker), and *Sesamia inferens* (Walker), 11 were from larvae, five from pupae and one from eggs.

The parasites considered promising most success in the biological control of these pests are those which attack the larval stage.

Of the 16 parasites discussed, five larval and pupal parasites have not been previously recorded in the Philippines.

Low production of rice due to widespread attack of rice stem borers in large rice-producing areas in the Philippines has established these insects as the most destructive pests of rice in this country. Four species of rice stem borers are known to occur in the Philippines, namely, *Schoenobius incertulas* (Walker), *Scirpophaga innotata* (Walker), *Chilo suppressalis* (Walker), and *Sesamia inferens* (Walker).

The larvae which feed and spend most of their life within the rice stalks makes control of these pests most difficult and poses an all important problem of rice culture in this country. An inexpensive control method of these pests is the utilization of their natural enemies, particularly the parasites.

In view of the comparatively low yield per hectare of rice fields exposed to borer attack and the lack of an inexpensive control method, this survey was conducted (1) to determine the different species of rice stem borer parasites in the areas surveyed, and (2) to know their importance in the biological control of the rice stem borers. Materials were studied in the laboratory of the Department of Entomology from May, 1954, to December, 1954. Field observations and surveys were made in some localities of Laguna, Rizal, and Pangasinan.

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[1] Central Experiment Station Contribution No. 1996. A special problem in Entomology 99 prepared in the Department of Entomology under the direction of Associate Professor Getulio B. Viado.

[2] The writer is grateful to Miss Clare R. Baltazar of the Bureau of Plant Industry, Manila for valuable suggestions and advice in the course of the survey, and for helping on references and synonymy.

Rowan (1923) reported that eggs of *Schoenobius* (*incertulas*) are parasitized by certain hymenopterous parasites. Thompson (1943) in his catalogue of parasites and predators, listed parasites of *Chilo simplex* and *Schoenobius incertulas* in the Philippines but did not mention the preferred host stage. Otanes and Sison (1952) reared three hymenopterous parasites from eggs of *Schoenobius*. Ishii (1953) studied the biology of *Spathius fuscipennis* Ashmead, an important larval parasite of *Chilo simplex* in the Philippines. His attempt to introduce the parasite to Japan was unsuccessful. Townes (1954) listed 15 parasites of rice stem borers in the Philippines, but did not mention the species of borer parasitized. He recommended four larval parasites for introduction, the type of parasites promising most success. He reported that before actual introductions are begun, there should be several weeks of collecting parasites in the Philippine rice fields to make certain that the species to be introduced do not already occur here. Jepson (1954) in his critical review of world literature on the lepidopterous stalk borers on graminaceous crops, presented a synoptic view of the parasites of the various stages of borers in the several geographical groups. He pointed out that the use of egg parasites in the biological control of borers would be restricted to Pyralid borers since those of the Agrotids are not exposed to attack.

Attempts are being made by the Bureau of Plant Industry to introduce into the Philippines parasites from Japan and Taiwan to assist in the biological control of these important pests. Last July, 1954, Dr. Gonzalo Merino of the Bureau of Plant Industry, introduced into the Philippines from Japan and Taiwan two egg parasites of *Chilo simplex*, namely, *Trichogramma japonicum* Ashmead and *Trichogramma australicum* Girault. These have been multiplied and released in 16 provinces in Luzon and in Palawan. Recovery of these parasites has not as yet been reported.

MATERIALS AND METHODS

Prior to the collection of host materials (eggs, larvae and pupae of the different species of rice stem borers), surveys were made to locate fields heavily infested with borers. Infestation was determined by (1) the abundance of egg clusters on the leaves or leaf sheaths and (2) the presence of white heads or empty panicles. Materials were obtained in College, Bay and Los Baños, Laguna; San Mateo, Rizal; and Binmaley and San Manuel, Pangasinan.

Collection of eggs. The collection of host-egg clusters was made in rice fields where plants had been transplanted for about three to 12 weeks. The collected materials were placed in test tubes and later sorted in the laboratory into the different species of stem borers. Egg clusters of each species were placed in shell vials plugged with cotton. Each contained a piece of white blotting paper to absorb excess water and retain moisture. The vials were placed on slant vial racks to facilitate the moistening and the examination of the contents. Each vial was examined daily for the emergence of the parasites. The larvae that hatched were transferred to breeding cages for possible rearing of egg-larval parasites. Adult parasites were collected and kept in gelatin capsules. A good series was mounted on pins for identification.

Collection of larvae and pupae. Collections of host materials for obtaining parasites were made before and after harvesting the rice, during which full-grown larvae and pupae were found. Most collections of larvae and pupae were made on the standing rice stalks in the fields. The rice stalks were cut at the base of the stalks, tied into bundles and brought to the laboratory for dissecting and removing the larvae and pupae found therein. The larvae were transferred individually into fresh stalks cut between internodes about four to six inches long. Twenty-five to thirty cut stalks containing the same species were placed in battery jars covered with screen cloth. Precaution was taken to prevent the ants from entering the jars. Blotting paper was placed at the bottom of the jars to absorb excess water and to retain moisture.

Since normal development of the larvae was impossible in a dry atmosphere, the ends of the rice stalks were kept in water during the developmental period. Some of the *Schoenobius* larvae brought to the laboratory were attacked by the fungus *Penicillium* sp.[3] The entire lot of material was examined twice a week. Each larva was transferred to freshly cut rice stalks until pupation took place. Rice stalks containing newly formed cocoons and pupae were removed from the jars and placed in the breeding cages for emergence.

The pupae in the dissected rice stalks were separated from the larvae. Each species was placed in battery jars covered with screen cloth and examined twice a week.

[3] Identified by Mrs. Victoria M. Ela of the Department of Plant Pathology.

All the parasites that issued from the host larvae and pupae were pinned for identification.

Collection of adult moths. Light trapping was employed in the collection of adult moths for cases of phoresy, a form of behavior characteristic of certain insects which cling to larger species in order to reach and parasitize their eggs.

Collections were made whenever moths were abundant during the night. Each species of collected adults was placed in breeding cages containing rice seedlings for oviposition. Leaves and leaf sheaths containing egg clusters were collected and placed separately in shell vials. Each vial was examined daily for the emergence of the parasites. Adult parasites found on the female moths were collected and pinned. Parasites that emerged from the parasitized eggs were also collected and placed in gelatin capsules. Some were mounted on pins for identification.

Identification of the parasites. The parasites were identified by Miss Clare R. Baltazar, Bureau of Plant Industry, Manila, and Dr. Henry K. Townes, North Carolina State College, Raleigh, North Carolina.

RESULTS AND DISCUSSION

The following is a list of parasites reared from eggs, larvae and pupae of the three species of rice stem borers *Schoenobius incertulas* (Walker), *Chilo suppressalis* (Walker), *Sesamia inferens* (Walker) collected from Laguna, Rizal, and Pangasinan. Parasites of *Scirpophaga innotata* (Walker) were not included in the survey because of the unavailability of the borer, the distribution of which is apparently confined to the Visayas (Sison, 1929). The list includes synonyms, distribution (locality), and general description of the parasites.

BRACONIDAE

Microbracon chinensis Szepligeti (Identified by Dr. H. K. Townes).

Bracon chinensis Szepligeti

Amyosoma chilonis Viereck

Agathis noiratum Ishida

Microbracon chilocida Ramakrishna

Male and female. Body four to five mm. long and about 1.5 mm. wide at thorax. Antenna, top of head, propodeum, middle and hind legs, and abdomen black; head except top, fore legs and thorax reddish; wings blackish.

The red and black species is probably the most common larval parasite in the entire Asian Continent and has been described under different names (Jepson, 1954). The adult parasitize the host larva in the later instars.

The specimens were reared from *Chilo* and *Sesamia.*

Locality: College, Laguna; Masukol, Los Baños, Laguna; San Mateo, Rizal.

Shirakia schoenobii Viereck (Identified by Dr. H. K. Townes).

Bracon dorsalis Matsumura

Shirakia dorsalis Matsumura

Tropobracon luteus Cameron

Female. Body about five mm. long and about two mm. wide at thorax. General body color yellowish brown; antenna dark brown; ovipositor sheath black; wings clear.

The species has been recorded many times from *Chilo* and *Schoenobius* in Japan and Formosa (Jepson, 1954). Shiraki (1917) described and figured the species in Formosa.

A specimen was reared from host larvae of *Schoenobius.*

Locality: College, Laguna.

Stenobracon nicevillei (Bingham) (Identified by Miss C. R. Baltazar).

Bracon nicevillei Bingham

Stenobracon trifasciatus Szepligeti

Stenobracon maculata Matsumura

Macrocentus javanicus Ishida

Female. Body 12 to 14 mm. long and about 2.0 mm. wide at thorax; ovipositor 22 to 25 mm. long, and about twice as long as fore wing. General body color yellow; top of head and tip of abdomen black; antenna and ovipositor sheaths dark brown to black; fore wing with basal half yellowish, apical half with two dark bands and dark apex, hind wings yellowish with its outer margin cloudy.

Male. Similar to the female except for its smaller size, eight to 10 mm. long.

It attacks common borers of rice, sorghum and sugar cane in India and is often found in areas of greater rainfall (Ayyar, 1928); Cherian and Israel, 1938.

Adult specimens were reared from host larvae of *Sesamia* and *Schoenobius.*

Locality: College, Laguna; Masukol, Los Baños, Laguna.

Spathius sp. (Identified by Miss C. R. Baltazar).

Female. Body 3.5 to five mm. long and about one mm. wide at thorax. General body color yellowish brown to dark brown; antenna and ovipositor sheaths blackish; wings clear.

Male. Smaller than the female, about three mm. long and 0.5 mm. wide at thorax.

Many specimens were reared from host larvae of *Chilo.*

Locality: College, Laguna; Bay, Laguna.

Apanteles sp. (Identified by Miss C. R. Baltazar).

Male and *female.* Body about 3.5 mm. long and one mm. wide at thorax. Body black, except for yellowish brown legs and basal ventral half of abdomen; eyes hairy; wings clear.

Species unknown; however, a certain species, *Apanteles flavipes* (Cameron) from Japan, Taiwan, and India which is a larval parasite of *C. simplex* was recommended for introduction in the Philippines by Townes (1954).

Adults emerged from host larvae of *Schoenobius.*

Locality: Binmaley, Pangasinan.

ICHNEUMONIDAE

Xanthopimpla kuchingensis Cameron (Identified by Miss C. R. Baltazar).

Xanthopimpla dehrni Krieger

Female. Body about 12 mm. long (excluding ovipositor) and 1.8 mm. wide at thorax. General body color yellow except for the following black areas; top of head and continuing backward to the

occiput, transverse band on mesonotum, inconspicuous pair of dots on tergites three to five and seven, and ovipositor sheath; wings clear.

Male. Smaller than the female, about eight mm. long and 1.2 mm. wide at thorax. General body color similar to the female except that the pair of dots are found on tergites four to seven and also tip of abdomen black.

The occurrence of the species in the Philippines is attested by two specimens reared from host pupae of *Chilo.*

Locality: College, Laguna.

Xanthopimpla stemmator (Thunberg) (Identified by Miss C. R. Baltazar).

Ichneumon stemmator Thunberg

Xanthopimpla thoracalis Krieger

Xanthopimpla bimaculata Cameron

Xanthopimpla nursei Cameron

Xanthopimpla maculifrons Cameron

Xanthopimpla fascialis Szepligeti

Xanthopimpla stemmator Roman

Female. Body eight to 13 mm. long and 1.8 mm. wide at thorax. General body color yellow except for the following black areas: central part of frons and vertex; two subelongate spots on mesothorax; a pair of dots on propodeum, tergites one to five, and seven, and ovipositor sheath; antenna brown; wings clear.

Male. Smaller than the female, seven to 11 mm. long. General color similar to the female except that the dots are on all tergites.

It is well known in India, Formosa, and Indonesia and the hosts listed by Sonan (1929) are that of cane, rice and maize borer (Jepson, 1954).

The specimens were reared from host pupae of *Chilo.*

Locality: San Mateo, Rizal.

Xanthopimpla punctata (Fabricius) (Identified by Miss C. R. Baltazar).

Ichneumon punctatus Fabricius

Pimpla punctata Brulle

Pimpla transversalis Vollenhoven

Xanthopimpla punctata Krieger

Xanthopimpla brunneicornis Cameron

Xanthopimpla Kreigeri Szepligeti

Xanthopimpla trimaculata Matsumura

Female. Body about nine mm. long and about 1.8 mm. wide at thorax. General body color yellow except for the following black areas: ocellar area, transverse band on mesonotum, base of hind tibia, a pair of dots on propodeum and tergites one, three, five, and seven, and ovipositor sheath; antenna yellowish brown; wings clear.

The species is recorded in India, Ceylon, China, Japan, Formosa, Indonesia and the Philippines from *Chilo,* by Chu and Hsia (1937).

The adult emerged from host pupa of *C. suppressalis.*

Locality: San Maeto, Rizal; Binmaley, Pangasinan.

Xanthopimpla emaculata Szepligeti (Identified by Miss C. R. Baltazar).

Xanthopimpla immaculata Morley

Female. Body about 10 mm. long and about 1.8 mm. wide at thorax. General body color yellow without black marks, sometimes tip of abdomen blackish; ovipositor sheath black; wings clear.

The occurrence of this pupal parasite is attested by a specimen reared from *Chilo.*

Locality: College, Laguna; San Mateo, Rizal.

Horogenes lineatus (Ishida) (Identified by Dr. H. K. Townes).

Angitia lineata Ishida

Bioctes lineata Ishida

Trathala falvopedes Shiraki

Male and female. Body 7.0 to 8.0 mm. long and 1.5 mm. wide at thorax. General body color black; legs yellowish brown except for middle and hind coxae; antenna and ovipositor brown; wings clear.

This parasite is apparently of local importance in Taiwan (Townes, 1954). The occurrence of the species is attested by the specimens reared from host larvae of *Schoenobius* and *Chilo.*

Locality: College, Laguna; Masukol, Los Baños, Laguna.

Cremastus sp. (Identified by Miss C. R. Baltazar).

Male and female. Body seven to eight mm. long and one mm. wide at thorax, abdomen compressed. Head yellowish to reddish orange except for top of head; antenna, thorax and propodeum black; first two tergites and basal half of the third to the fifth last tergites, and ovipositor sheath black; legs yellowish brown except for hind femur and tarsus; wings clear.

Species unknown. Adults were reared from host larvae of *Schoenobius* and *Chilo*.

Locality: Masukol, Los Baños, Laguna; San Mateo, Rizal.

Cremastus shirakii (Sonan) (Identified by Miss C. R. Baltazar).

Female. Body about nine mm. long and 1.5 mm. wide at thorax, abdomen compressed. General body color yellow-orange, ocellar area, apex of hind femur, base of first and second tergites, and ovipositor sheath black; wings clear.

A larval parasite of local importance in Taiwan and its introduction to the Philippines is recommended by Townes (1954).

The occurrence of the Philippine species is attested by a specimen from *Schoenobius*.

Locality: San Manuel, Pangasinan.

Amauromorpha schoenobii (Viereck) (Identified by Miss C. R. Baltazar).

Eripternimorpha schoenobii Viereck

Female. Body about 10 mm. long and two mm. wide at thorax. Black and reddish. Antenna except for whitish ring at middle, head, thorax and abdomen black; apical margin of the seventh tergite white; propodeum reddish, legs mostly reddish with some black parts; wings clear.

Male. More slender than female; similar to the female in color except that the antenna is entirely black and the face has a central white spot and a sub-alar white spot.

In Japan and Formosa, it attacks a wide range of rice and cane borers including *Schoenobius* and *Sesamia* (Sonan, 1929).

The specimens were reared from host larvae of *Schoenobius*.

Locality: San Mateo, Rizal.

Goryphus sp. (Identified by Miss C. R. Baltazar).

Female. Body about eight mm. long and one mm. wide at thorax. Black and red. Antenna black except for whitish mark at middle; head and abdomen black except for white apical band of second and seventh tergites; thorax and propodeum reddish but suffused with black on pronotum and mesoscutum; legs black except for reddish coxae of middle and hind legs; wings clear and with a brown band at apical third of fore wing.

Species unknown. An adult emerged from host larva of *Chilo.*

Locality: College, Laguna.

Ischnojoppa luteator Fabricius

Male and female. Body about 14 mm. long and two mm. wide at thorax. General body color yellow-orange; black on the following parts; last two tergites, apical third of hind femur and tibia, and tarsus except for yellow basal half of first tarsal segment; antenna brownish yellow; wings clear; ovipositor not conspicuous, hardly protruding beyond the tip of the abdomen.

According to Jepson (1954), this parasite attacks the larva and the adult emerges from host pupa. The species is common in most Oriental regions. The specimens were caught in the rice fields, hence no record has been made as to the species of borer parasitized.

Locality: College, Laguna; San Mateo, Rizal.

SCELIONIDAE

Telenomus sp. (Identified by Miss C. R. Baltazar).

Female. Very minute species, about one mm. long and 0.2 mm. wide at thorax. Black with scape and legs yellowish-white. Antenna geniculate and clavate; thorax punctate; abdomen shiny with the side rimmed; wings clear with venation reduced.

Species unknown. Most authors agree that *Telenomus* is of little importance in Japan, Malaya, and India but it is possible that *Telenomus* is a natural egg parasite of top-shoot (Schoenobiinae) borers since it favors these hosts in Japan and Formosa (Jepson, 1954).

The Philippine specimens were reared from eggs of *Schoenobius.* Adults were also found attaching themselves to adult female moths.

Locality: College, Laguna; San Mateo, Rizal.

CHALCIDIDAE

Tetrastichus sp. (Identified by Miss C. R. Baltazar).

Female. Very minute species, about two to 2.5 mm. long and 0.5 mm. wide at thorax. Black with legs yellowish white. Antenna geniculate and clavate; body shiny throughout; face deeply concave; wings clear with venation reduced.

Species unknown. Several specimens were reared from host pupa of *Sesamia.* Accórding to Jepson (1954), few records exist of pupal parasitism by *Tetrastichus* in the Old World.

Locality: College, Laguna.

SUMMARY

Of the 17 species reared, 11 were larval parasites, five, pupal parasites and one, egg parasite.

The egg, larval and pupal parasites of the following rice stem borers are listed below:

Schoenobius incertulas (Walker)
Egg parasite:
Scelionidae
Telenomus sp.
Larval parasites:
Braconidae
Shirakia schoenobii (Viereck)
Stenobracon nicevillei (Bingham)
Apanteles sp.
Ichneumonidae
Horogenes lineatus (Ishida)
Cremastus shirakii (Sonan)
Amauromorpha schoenobii (Viereck)

Chilo suppressalis (Walker)
Larval parasites:
Braconidae
Microbracon chinensis Szepligeti
Spathius sp.
Ichneumonidae
Horogenes lineatus (Ishida)
Goryphus sp.
Pupal parasites:

Ichneumonidae
Xanthopimpla stemmator (Thunberg)
Xanthopimpla kuchingensis (Cameron)
Xanthopimpla emaculata Szepligeti
Xanthopimpla punctata (Fabricius)

Sesamia inferens (Walker)
Larval parasites:
Braconidae
Microbracon chinensis Szepligeti
Stenobracon nicevillei (Bingham)
Pupal parasite:
Chalcididae
Tetrastichus sp.

The parasites considered promising most success in the biological control are those which attack the larval stage; among them are: *Microbracon chinensis, Stenobracon nicevillei, Shirakia schoenobii, Apanteles* sp., *Cremastus shirakii,* and *Horogenes lineatus.*

Of the 17 parasites discussed the following have not been previously recorded in the Philippines: *Goryphus* sp., *Xanthopimpla kuchingensis, Xanthopimpla emaculata, Cremastus shirakii,* and *Tetrastichus* sp.

Telenomus sp., an egg parasite, was observed to exhibit a phenomenon called phoresy.

Most adult parasites parasitized the host larvae in the later instars.

Pupal parasites are generally less important, because they parasitize the borer at a very late stage.

The possible utilization of the predators and diseases in controlling the borers was not given any consideration, but it does not mean that they are unimportant. A fungus, *Penicillium* sp., was found attacking the larvae of *Schoenobius.*

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EFFECT OF CONTINUOUS SUBMERGENCE OF VARIOUS DEPTHS OF IRRIGATION WATER ON THE GROWTH AND YIELD OF LOWLAND RICE [1]

A. B. Catambay, H. E. Gray, A. P. Aglibut, and J. L. Ordoveza [2]

Results from two-season tests showed no significant difference in the yield as affected by 5-, 10-, 15-, and 20-cm. depths of submergence. Economy in irrigation water was effected by using 5-cm. depth of submergence without materially affecting the yield of lowland rice.

The factors which influence the degree and extent of practising irrigation effectively on lowland or paddy rice are the growing season, weather conditions, variety of crop, adequate water supply, and technical and practical knowledge in the use and management of irrigation water. Even when the culture coincides with the wet or rainy season, supplemental irrigation of rice is often necessary due to the uneven distribution of rainfall. During the dry season irrigation becomes the main factor that affects the production of lowland rice.

Water is supplied to the paddy either by continuous submergence or by intermittent submergence. Literature on irrigating lowland or paddy rice shows that no single method of irrigation is used exclusively in a country. In the United States, continuous and intermittent submergence are practised. Reynolds [3] reported that Texas uses more of the intermittent method. In California, rice is sown on fields submerged in two to four inches of water. Jones *et al.*[4] found that in continuous submergence, rice is submerged in four to eight inches of water and maintained at the latter depth until the crop is nearly ready for harvest.

Paddy rice is produced in Japan by submerging the fields soon after, or even as early as transplanting time and draining the field once toward the end of the tillering stage (Matsuo, 1955).[5]

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[1] Central Experiment Station Contribution No. 1997. Based on a paper read at the first Southeast Asia Soil Science Conference, Manila, Philippines, December 9-22, 1957.

[2] Respectively, Professor and Head, Department of Agricultural Engineering; Cornell Visiting Professor, 1956-57; Research Associate Professor of Agricultural Engineering; and Assistant Professor of Agricultural Engineering.

[3] E. B. Reynolds, *Texas Agric. Exper. Sta. Bull.*, 775 (1954).

[4] J. W. Jones *et al.*, *USDA Farmer's Bull.*, **32** (1950).

[5] T. Matsuo, "Rice Culture in Japan," Tokyo, Japan, Yokendo Ltd., 1955.

This study was conducted to determine the effect of 5-, 10-, 15-, and 20-cm. depths of continuous submergence on the growth and yield of lowland rice.

The experiment was conducted on the lowland rice field of the Central Experiment Station for two crop seasons from September, 1956, to January, 1957, and from April to August, 1957.

MATERIALS AND METHODS

Two 8-plot rows, each plot measuring 5 × 8 meters, were used. The dikes surrounding each plot were made of four-inch reinforced concrete extending to 70 centimeters below the soil surface and projected 30 centimeters above. Each plot was provided with four 2-inch drain pipes embedded in the concrete dike at different levels above the soil surface. These served as water inlets when the plots were irrigated.

In both plantings the soil was sufficiently soaked prior to land preparation. The plots were plowed once with animal-drawn moldboard plow and harrowed three times with comb-tooth animal-drawn harrow. Final leveling with the harrow was done on the day the seedlings were transplanted. These operations were spaced by one-month periods. The plots were submerged continuously during the period of land preparation.

Seedlings of *Tjere Mas,* a medium early variety, were sown in a well-prepared seedbed on July 23, 1956; the seedlings were pulled, topped and transplanted on August 20; missing hills were replanted on August 30; and the crop, harvested on December 17, 1956. In the second crop, the seeds were sown on March 8, 1957; pulled from the seedbed, topped, and transplanted on April 5, and harvested on August 24, 1957.

The seedlings were set at 25 × 25 centimeters. Three seedlings were transplanted to a hill. Replanting of missing hills was done within 10 dys after transplanting.

Three days after transplanting, the plots were started on each depth of submergence. The distribution of the plots followed a pattern to facilitate statistical analysis of the results.

Depth of water in every plot was measured with direct reading gauges at 7:00 a.m. and 5:00 p.m. each day. Additional depth readings were recorded immediately before and after submergence. Pre-

cipitation was recorded from a rain gauge installed at the center of the experimental area.

The readings at 7:00 a.m. and 5:00 p.m. served for daytime and night time water uses, making the necessary correction due to rain. The difference between readings at 7:00 a.m. and 5:00 p.m. during rainless days gave the average water use during the day and the difference in depth readings between 5:00 p.m. and 7:00 a.m. gave the average water use of the plants during the night.

The yield from each plot was determined soon after threshing and winnowing. Samples for moisture determination of grain at harvest were taken and weighed soon after winnowing.

Tiller counts and height of the tall, medium-sized and short plants were obtained using five hills in each plot. The hills were picked using the coordinate system.

Other data collected were dates of flowering, heading and degree of lodging of the plants in the plots. The plots which were weeded every 30 days were not fertilized and the plants, not sprayed with insecticides.

RESULTS AND DISCUSSION

Effect on grain yield. Table 1 shows the yields of grain at 14 per cent moisture content from the two plantings. While the individual plots apparently showed variation in yields, their differences were not statistically significant. The average yields from the four depths in the two plantings are almost the same. These results confirm earlier findings of Aglibut and Hoff.[6]

Effect on tillering. Table 1 also shows the effect of depth of continuous submergence upon tillering of five randomly-selected hills from each plot of *Tjere Mas.* In the case of grain yield, tillering of *Tjere Mas* was not affected significantly by depth of continuous submergence. These results vary from the findings of Matsuo [7] who reported better tillering of rice plants in Japan at three-to-five-centimeter depths of irrigation during the tillering stage.

The average number of tillers per hill was slightly more in the second than in the first planting.

[6] A. P. Aglibut and P. R. Hoff, *Philippine Agriculturist*, **39**, 453-464 (1956).
[7] Matsuo, *op. cit.*

TABLE 1.—*Average yield, number of tillers per hill and height of tillers from two plantings of Tjere Mas given different depths of continuous submergence*

PLANTING	DEPTH OF SUBMERGENCE (cm.)	CHARACTERS [a]					
		Yield		Tiller			
					Height (cm.)		
		Kilogram	Cav./ha.	Number	Tall	Medium	Short
First	5	10.07	62.17	12.45	146.0	132.2	116.3
	10	10.72	66.19	13.50	147.3	132.6	113.4
	15	11.53	71.19	13.30	147.9	135.5	115.7
	20	11.67	72.05	13.75	147.2	135.6	120.5
Grand mean		10.98	67.90	13.25	147.1	134.0	116.5
Second	5	11.99	74.03	15.55	157.6	147.7	128.9
	10	10.09	62.30	18.00	158.7	148.7	133.7
	15	12.03	74.27	17.30	159.2	148.0	125.0
	20	12.44	76.80	15.15	162.3	149.1	123.8
Grand mean		11.76	71.85	16.50	159.9	148.4	127.9

[a] No significant difference between effects of depth of submergence on the characters was noted.

Effect on final height of tillers. Table 1 further shows that within each height class (tall, medium, and short), no significant differences were produced by the four depths of irrigation. However, all the tillers in the second planting grew a few centimeters taller than those in the first planting.

Water use as affected by depth of irrigation. The irrigation water applied to the paddy is used and disposed of by the plants through transpiration, evaporation from the water surface, percolation, seepage and outflow from the plots.

The amount of water needed which should be supplied by irrigation is the irrigation requirement of a crop. The season of the year, whether wet or dry, materially affects the irrigation requirement. In this experiment percolation and seepage were low; this was probably due to the presence of hard pan below the surface soil and concrete dikes enclosing the plots.

The drop of water level in the plots as measured daily by gauges at 7:00 a.m. and 5:00 p.m. gave the average daily water use on rainless days. When it rained correction was made to exclude the rainfall during the day. In this manner, the average depletions of water in the plots during the day and during the night were determined. Table 2 shows the average daily depletions for the season by night

and by day. The results show higher water use during the daytime than during the night time. Analysis of the figures in the same table gave the average water use for two seasons which are as follow: 5-cm. depth of submergence, 110 cm.; 10-cm. depth, 192 cm.; 15-cm. depth, 230 cm.; and 20-cm. depth, 240 cm. It is apparent that more water was needed at deeper submergence. This may be explained by the presence of higher static pressure at greater depths which possibly causes greater percolation.

TABLE 2.—*Average daily water use in cm. of* Tjere Mas *under four depths of continuous submergence*

DEPTH OF WATER IN CM.	NIGHT	DAY	AVE. 24 HRS.	NIGHT	DAY	AVE. 24 HRS.	NIGHT	DAY	AVE. 24 HRS.	NIGHT	DAY	AVE. 24 HRS.	NIGHT	DAY	AVE. 24 HRS.
							FIRST PLANTING								
	September			*October*			*November*			*December*					
5	0.39	0.68	1.07	0.32	0.81	1.13	0.47	0.75	1.22	0.52	1.45	1.97			
10	0.92	1.23	2.15	0.52	1.22	1.74	0.74	1.44	2.18	0.28	2.40	2.68			
15	1.12	1.71	2.83	0.64	1.55	2.19	0.78	1.69	2.47	0.46	2.05	2.51			
20	2.32	1.58	3.90	1.52	1.55	3.07	1.63	2.80	4.43	0.58	3.44	4.02			
							SECOND PLANTING								
	April			*May*			*June*			*July*			*August*		
5	0.58	1.54	2.12	0.35	1.19	1.54	0.33	1.17	1.50	0.61	1.14	1.75	0.54	1.06	1.60
10	1.46	4.47	5.93	0.81	2.31	3.12	0.45	1.42	1.87	0.66	1.42	2.08	0.66	1.56	2.22
15	1.63	4.29	5.92	0.83	2.56	3.39	0.61	1.69	2.30	0.84	1.81	2.65	0.88	1.94	2.82
20	2.45	6.86	9.31	0.96	2.43	3.39	0.52	1.50	2.02	0.85	1.96	2.81	0.98	2.66	3.64

Average for month = Total water use in cm. per 24 hours × number of days.

A FIELD TEST ON THE USE OF INSECTICIDES AND COVER-CROPPING AND THEIR BEARING ON THE CONTROL OF ABACÁ MOSAIC [1]

G. B. VIADO and J. G. MATTHYSSE [2]

WITH ONE TEXT FIGURE

Among the indirect methods used in minimizing abacá mosaic infection, cover-cropping with *Cestrosema plumieri* was the best, followed by BHC in which both the abacá plants and the weeds were sprayed, and Systox in which only the abacá plants were sprayed. Systox used as seed-piece treatment in addition to spraying of the ensuing plants was the poorest, giving 32.9 per cent of mosaic infection compared to 33.4 per cent in the control. None of the treatments prevented either mosaic infection or aphid infestation. Roguing the mosaicked stools throughout the test did not reduce mosaic incidence in all the plots. The results of the present investigation seem to indicate the existence of other unknown factors responsible for the manifestation of the symptoms of the disease, its latency, or its complete disappearance from the abacá plant.

The abacá mosaic has long been a destructive disease of abacá in Mindanao, the center of the abacá industry in the Philippines. While much progress has been made towards the control of this malady, no relatively easy, effective and practical method of control has as yet been found. This difficulty is attributed to the complexity of the disease. It is suspected that at least five viruses are involved in the abacá mosaic, namely, those of the true abacá mosaic, corn mosaic, sugarcane mosaic, canna mosaic, and grass mosaic. This is complicated by the presence of several species of insect vectors which transmit the disease not only from abacá to abacá but also from weeds to abacá.

Various investigators (Calinisan, 1934; Celino, 1940; Ocfemia, 1949; Reyes, 1952; and Ocfemia, 1954) recommended eradication of infected stools and avoidance of seed pieces from mosaic-infested areas as effective means of controlling the disease. The failure of

[1] Central Experiment Station Contribution No. 1998.

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abacá planters to carry out this recommendation is an indication that other means of control should be sought.

The use of insecticides for the control of abacá mosaic vectors was reported by Castillo *et al.* (1954) who conducted a study on the rate of spread of mosaic disease in plantations sprayed with insecticides. No other data on the use of chemicals directly or indirectly, as a means of controlling this disease in the Philippines is readily available. To determine the effects of Systox and BHC treatments and cover-cropping on the incidence of mosaic and on the aphid population, this experiment was conducted at the Odell Plantation, Madaum, Tagum, Davao province, from September, 1955, to July, 1956.

MATERIALS AND METHODS

The insecticides used were 47 per cent Systox emulsifiable concentrate used at the rate of one pint per 100 gallons of water, and BHC wettable powder containing 10 per cent gamma isomer, which was used at the rate of four pounds per 100 gallons of water.

The six-hectare experimental field was cleared inside a virgin forest, isolated from abacá plantings. The nearest abacá field was about half a kilometer from the experiment.

The field was divided into three randomized blocks, each containing six plots, five treated and one control. Each plot was 50 by 66⅔ meters with an area of about one-third of a hectare. The treatments were as follows:

A—Systox. The abacá seed pieces were dipped in the insecticide spray solution for 30 minutes and the ensuing plants sprayed.
B—Systox. Both the abacá plants and the weeds were sprayed.
C—Systox. Only the abacá plants were sprayed.
D—BHC. Both the abacá plants and the weeds were sprayed.
E—Cover crop. The plot was cover-cropped with *Centrosema plumieri.*
Control—No treatment.

The seed pieces were taken from apparently healthy plants in fields within the plantation known to be free from mosaic. The plots were planted from September 16 to 22, 1955, with seed pieces varying in number from 751 in plot C, block III, to 910 in plot F, block I. The difference in the number of hills to a plot was brought about

by the big logs felled during the clearing of the area which prevented planting of the space covered by the logs.

Spraying was done with the use of a power sprayer, using all necessary precautions to protect the operator from the chemicals. Particular attention was given to the base of the youngest leaves where aphids prefer to feed. Seven monthly applications were made, the first at two months from planting when most of the plants were about one foot tall and had three leaves.

On March 16 and 17, 1956, six months from planting, the percentages of abacá hills, *Paspalum conjugatum, Gynura crepidiodes* and *Eleusine indica* infected with aphids were taken, based on 25 hills or plants to a plot taken at random.

The number of hills infected with mosaic was recorded monthly and the infected hills were rogued after counting. The test was terminated ten months after planting.

A survey of the weeds and their relative abundance in four different newly-opened fields planted to abacá within the plantation was conducted on November 10, 1955, to determine the weed species prevalent in the area.

EXPERIMENTAL RESULTS

The dates of spray applications and the total amount of insecticide concentrates and spray solutions used in each treatment are shown in table 1. The average amount of spray used on the plants per plot was 82.1 gallons, which was less than half of that used on the weeds (169.4 gallons).

Effects on the abundance of aphids. Two species of aphids, *Aphis maidis* Fitch and A. *gossypii* Glover were reported by Castillo *et al.* (1954) as the principal vectors of abacá mosaic in Davao. These authors found that *A. maidis* had preference for grass while *A. gossypii* was common on abacá and weeds other than grasses.

A survey to determine the extent of aphid infestation on the abacá plants and on the weeds was taken on March 16 and 17, 1956, six months after planting (table 2). At that time four sprays had already been applied. No aphid was found on any of the 75 hills of abacá examined in either treatment C or D while 5.3 per cent of the hills in treatment B were infested with aphids. Treatment E had an infestation of 4.0 per cent, treatment A, 2.7 per cent and the control, 1.3 per cent.

TABLE 1.—*Date sprayed and total amount of insecticide concentrates and sprays used in each treatment*

TREATMENT	DATE SPRAYED	INSECTICIDE CONCENTRATE USED		GALLONS SPRAY USED
		Insecticide	Amount	
			ml.	
A	5, 6—XII—1955	Systox	1,260	252 [a]
	5—I —1956		300	60
	7—II — "		360	72
	6—III — "		465	93
	5—IV — "		440	88
	5—V — "		440	88
	7, 8—VI — "		700	140
B	18 to 21—XI —1955	Systox	1,240	248
	20—XII— "		1,260	252
	19—I —1956		1,260	252
	21—II — "		1,260	252
	21—III — "		1,260	252
	20—IV — "		1,260	252
	21, 22—V — "		1,260	252
C	19 to 21—XI —1955	Systox	285	57
	21—XII— "		240	48
	20—I —1956		300	60
	23—II — "		360	72
	23—III — "		480	96
	21—IV — "		480	96
	22—V — "		600	120
			lbs.	
D	10, 11—XI —1955	BHC	9.9	249
	12, 13—XII— "		10.0	252
	11—I —1956		10.0	252
	10—II — "		10.0	252
	12—III — "		10.0	252
	11—IV — "		10.0	252
	11—V — "		10.0	252

[a] Includes solution used in soaking the seed pieces.

Of the three species of weeds examined, *Gynura crepidiodes* contained the most plants infested with aphids in all the treatments except treatment E in which *Eleusine indica* had higher infestation than *Gynura*. Aphids on *Eleusine* were found only in treatments B and E and on the control. A plant of *Paspalum conjugatum* infested with aphids was found only in treatment B. No aphid was found on this plant in the other treatments and the control. It is of interest to note that in treatment E (cover-cropped) a high percentage of the *Eleusine indica* contained aphids. This may have been due to the fewer number of this weed in this treatment than in the other treatments.

TABLE 2.—*Per cent hills and weeds infested with aphids in the various treatments* [a]

TREATMENT	INFESTED ABACA HILLS	WEED INFESTED		
		Paspalum conjugatum	*Gynura crepidiodes*	*Eleusine indica*
A	2.7	0	8.0	0
B	5.3	1.3	1.3	1.3
C	0	0	5.3	0
D	0	0	1.3	0
E	4.0	0	2.7	10.7
Control	1.3	0	1.3	1.3

[a] Data taken March 16-17, 1956, six months from planting. Based on 25 plants to a plot, taken at random.

Effects on the incidence of mosaic. The mean per cent hills infected with mosaic and subsequently rogued in the various treatments was taken approximately every 15 days, starting at about two months from planting (table 3). The height of infestation in all the treatments including the control was on February 16, about five months after planting, in which 5.83 per cent of the hills in the control plots came down with mosaic compared with 5.21 per cent in treatment A, 4.08 in treatment B, 2.37 in C, 2.12 in D, and 1.58 in E. There was a decline in infection after February 16 up to June 14, followed by a marked increase on July 6. Based on the mean per cent hills infected with mosaic, the best was treatment E in which the plots were cover-cropped with *Centrosema plumieri,* giving only 12.3 per cent of the hills infected, compared with 33.4 in the control (fig. 1). The next best was treatment D (BHC) with 17.4 per cent, followed by C (Systox sprayed on abacá) with 20.8, B (Systox sprayed on abacá and weeds) with 28.6 and A (Systox, soaked and sprayed on abacá) with 32.9. The incidence of mosaic in the plots where the seed pieces were soaked in Systox and the ensuing plants sprayed was almost as high as that in the control.

The plots in which both the abacá plants and the weeds were sprayed gave higher incidence of mosaic on the abacá than those in which only the abacá plants were sprayed. The mean per cent infected hills in treatment B where the abacá and the weeds were sprayed with Systox was 28.6 per cent, compared with 20.8 per cent in those where only the abacá plants were sprayed. Castillo *et al.* (1954) reported the beneficial effects of spraying abacá plantations with "Foliafume" and DDT with oil for the control of aphids.

TABLE 3.—*Mean number of hills planted and per cent hills infected with mosaic and rogued at different dates during the test*

TREATMENT	HILLS PLANTED	1955 XI-28	XII-13	XII-28	1956 I-10	I-28	II-16	III-1	III-16	IV-4	IV-17	V-5	VI-1	VI-14	VII-6	MEAN TOTAL HILLS INFECTED	
																Number	Per cent
A	844.7	0.20	0.67	1.22	1.81	2.49	5.21	3.79	2.84	3.91	2.37	2.81	1.66	0.98	3.00	278.3	32.9
B	808.3	0.12	0.33	1.03	0.83	1.61	4.08	4.08	2.56	3.96	2.14	2.39	1.32	0.90	3.22	231.0	28.6
C	844.7	0.08	0.59	0.98	0.98	1.18	2.37	2.33	2.28	2.01	1.93	1.69	1.34	0.71	2.33	176.0	20.8
D	851.0	0.15	0.20	0.94	0.94	0.82	2.12	1.45	2.00	1.96	1.49	1.56	1.41	0.71	1.68	148.3	17.4
E	803.7	0.21	0.78	0.58	0.75	1.12	1.58	0.96	1.33	1.03	1.00	0.75	0.58	0.41	1.21	98.7	12.3
Control	835.0	0.04	0.40	0.80	1.80	2.84	5.83	4.07	4.43	4.79	2.79	2.31	1.16	0.84	1.56	279.0	33.4

307 B-III	174 Control III	113 D-III	174 C-III	159 A-III	98 E-III
84 E-II	191 C-II	116 B-II	285 A-II	201 Control II	153 D-II
391 A-I	179 D-I	163 C-I	114 E-I	270 B-I	462 Control I

Fig. 1.—*Layout of experimental area at Odell Plantation, showing total number of hills infected with mosaic in the various treatments and blocks.*

The removal of infected stools did not reduce mosaic incidence in all the plots. There was almost consistent increase of infected hills from the time bi-weekly observations started on November 28, 1955, to February 16, 1956, in spite of roguing after each observation. Castillo *et al.* (1954) found that complete eradication of diseased plants eventually controls the disease.

Weeds prevalent in the plantation. A survey made on the weeds prevalent in four abacá fields planted at different dates at Odell Plantation showed 46 species (table 4). The most abundant species were *Paspalum conjugatum, P. longifolium, Eleusine indica, Panicum patens, Imperata cylindrica, Euphorbia hirta, Piperomia pellucida, Merremia peltata, Centrosema pubescens, Gynura crepidiodes, Ageratum conyzoides, Digitaria sanguinalis, Alternanthera ficoides, Physallis angulata, Pteris* sp., and *Blumea laciniata.* Of the graminaceous weeds, only *Eleusine indica* and *Paspalum conjugatum* were found most commonly infested with aphids, while among the other weeds only *Gynura crepidiodes.*

DISCUSSION

If the proportion of hills infested with aphids were to be used as a criterion in determining how widespread the mosaic incidence could be, cultures C, D and the control might be expected to have the least (table 2). However, the expectation was not borne out by the data on the number of infected hills (table 3). To reconcile the expectation with the facts, it may be argued that since the differences are rather small, they are probably fortuitous. Or, that the aphids, whatever was the extent of their role in spreading infec-

TABLE 4.—*Weeds and their relative abundance in four different newly opened fields planted to abacá at Odell Plantation, at the time of observation, November 10, 1955* [a]

WEED		DATE FIELD PLANTED TO ABACA			
Scientific name	Family	Nov. 1954	Feb. 1955	July 1955	Sept. 1955
Paspalum conjugatum Berg.	Gramineae	xx	xx	xx	x
P. longifolium Roxb.	"	xx	xx	xx	x
Eleusine indica (L.) Gaertn.	"	xx	xx	xx	x
Echinochloa colonum Link.	"	x	xx	0	0
Cynodon dactylon (L.) Pers.	"	x	0	0	0
Digitaria sanguinalis (L.) Scop.	"	xx	xx	x	0
Panicum patens L.	"	xx	xx	xx	x
P. flavidum Retz.	"	0	0	x	0
Imperata cylindrica (L.) Beauv.	"	xx	xx	xx	x
Oplismenus compositus (L.) Beauv.	"	0	0	0	x
Cyperus flabilliformis Rottb.	Cyperaceae	x	x	0	0
Scleria scrobiculata Nees.	"	0	x	0	x
Kyllinga monocephala Rottb.	"	x	x	0	0
Donax cannaeformis Forst.f.	Maranthaceae	x	0	0	x
Tetrastigma harmandii Planch.	Vitaceae	x	0	0	0
Columella trifolia (L.) Merr.	"	x	0	0	0
Euphorbia hirta L.	Euphorbiaceae	xx	xx	xx	x
Phyllanthus niruri L.	"	xx	0	0	0
Drymaria cordata (L.) Willd.	Caryophyllaceae	xx	0	0	0
Peperomia pellucida (L.) HBK.	Piperaceae	xx	xx	xx	x
Piper sp.	"	x	x	x	x
Costus speciosus (Roen) sm.	Zingiberaceae	0	x	0	0
Solanum ferox L.	Solanaceae	0	x	0	0
Sida retusa L.	Malvaceae	0	x	x	0
Smilax bracteata Presl.	Liliaceae	x	x	0	0
Passiflora foetida L.	Passifloraceae	x	x	x	x
Tenospora sp.	Menispermaceae	0	x	0	0
Melothria indica Lour.	Cucurbitaceae	x	x	x	0
Fleurya interrupta (L.) Gaudich.	Urticaceae	x	0	0	0
Portulaca oleracea	Portulacaceae	x	x	x	x
Lygodium japonicum (Thunb.) Sw.	Schizaceae	x	x	0	0
Alteranthera ficoides (L.) R. Br.	Amaranthaceae	xx	xx	x	0
Physallis angulata L.	Solanaceae	xx	x	xx	x
Merremia peltata (L.) Merr.	Convulvulaceae	xx	xx	xx	x
Melochia concatenata L.	Tiliaceae	0	x	x	0
Oldenlandia biflora L.	Rubiaceae	0	x	x	0
Scoparia dulcis L.	Scrophulariaceae	0	x	0	0
Melastoma sp.	Melastomataceae	0	x	0	0
Selanginella sp.	Selanginellaceae	xx	x	x	x
Pteris sp.	Pteridaceae	xx	xx	x	x
Cynanotis cristata (L.) Res.	Commelinaceae	x	x	x	x
Centrosema pubescens Benth.	Leguminosae	xx	xx	xx	x
Blumea balsamifera (L.) DC.	Compositae	xx	x	x	x
B. laciniata (Roxb.) Beth. DC.	"	xx	xx	x	x
Gynura crepidiodes	"	xx	xx	xx	x
Ageratum conyzoides L.	"	xx	xx	xx	x

[a] The weeds were identified by Messrs. J. V. Pancho and G. C. Lugod of the Department of Agricultural Botany. 0 = absence of weed; x = few; xx = abundant.

tion in this experiment, were not primary factors in the incidence of the disease. It could be that the seed pieces were already infected and the virus was in the latent state. Then some factor or factors in the environment must have been the immediate cause of the manifestation of disease symptoms.

The latter alternative gains weight with the incidental observation on another unrelated planting. This plantation, which was located at Tambanan, Kabasalan, Zamboanga del Sur and managed by the Matutum Agricultural Development Corporation, General Santos, Cotabato, had an area of about 50 hectares. The senior author was informed by the manager of the plantation that the seed pieces were secured from fields in General Santos, Cotabato, where the incidence of abacá mosaic was very high. The manager said that a very conservative estimate was that at least two per cent of the seed pieces came from mosaicked plants. On June 25, 1956, a trip was arranged by the senior author, Dr. R. W. Dean, entomologist, and Dr. C. H. Reddy, plant pathologist, both Cornell visiting professors and Dr. F. T. Orillo, head of the Department of Plant Pathology, all of the College of Agriculture, U.P., to visit the plantation. The plantation was completely neglected at the time of the visit. The reason given was the poor price of abacá fiber and the plan of the management to use the area for planting rubber trees. After a day of exhaustive search for an abacá plant infected with mosaic, the members of the party came to the conclusion that the plantation was free from mosaic. The presence of aphids on some plants of *Paspalum conjugatum* and *Euphorbia hirta* and both aphids and *Proutista moesta* on *Rottboellia exaltata* among the abacá plants was noted. The manager of the plantation informed the members of the party that since the establishment of the plantation five years previous to the visit, he did not notice a single abacá plant infected with mosaic. This finding appears to indicate the presence of other unknown factors involved in the manifestation of the symptoms of the disease, its latency, or its complete disappearance.

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FARM BUSINESS MANAGEMENT OF COCONUT FARMS [1]

E. U. Quintana, B. N. de los Reyes and J. M. Marasigan

The tenure status and characteristics of coconut farmers in the three provinces studied varied greatly. Incidence of tenancy among the farmers interviewed was higher in the Bicol provinces (Camarines Sur and Albay) than in Quezon. Farmers in Quezon were older and had more experience in farming. The average educational attainment of farmers was highest in Camarines Sur and lowest in Albay.

Farmers in Quezon had higher income than those in the Bicol provinces. This was due mainly to the high production rates in Quezon which was about 7,464 nuts per hectare or about 36 nuts per tree per year.

There was a positive relationship between size of farm and income on coconut farms. As size of farm increased, farmers' income also increased. Economy in labor and smaller overhead costs on large farms were mainly responsible for this relationhip.

Farm incomes of coconut farmers can be increased by activities as broom-making from coconut leaves and gathering midribs for fuel, intercropping and livestock raising.

The coconut industry is the premier dollar-producing industry of the Philippines. Annually the industry earns for the country about $150,000,000 in foreign exchange, which is one-fourth of the total foreign trade payments. It covers more than thirty provinces and about eight million people or more than one-third of the entire population depend upon the industry for livelihood.

Although the industry enjoys a satisfactory situation today it is still faced with many varied problems among which is technological improvement. The coconut farmer who inherited his ancestors' way of farming is indifferent to any move in improving farm practices. This is a serious problem because coconut production in the country is mostly in the hands of small farmers. The Philcoa (Philippine Coconut Administration) annual report for 1955-56 states the problem thus:

> "The coconut industry is in the hands largely of small holders of an average of five hectares. While in many respects a healthy feature, the presence of an average of so many marginal producers makes the problem

[1] Central Experiment Station Contribution No. 1999.

more complicated. Marginal producers are not conducive to sound management. They are resistant to change and to promotions of group or cooperative action."

Only a few economic studies have been made concerning this industry, most of which were done during pre-war days. Robertson and Bratton [2] (1952) conducted a study on investment and income of tenant farmers in San Pablo City, and reported that the average area of a farm was 2.7 hectares; the average investment, ₱1166, and the average farm income, ₱258.

Robertson and Tablante [3] (1952) studied investment and income on 132 coconut farms in Indang, Cavite. They reported that owner-operated farms averaged two hectares, 1.5 being in coconuts, and that tenant-operated and partly-owned farms were larger and had approximately two hectares in coconuts. Owner-operators had an average capital of ₱3761, a net farm income of ₱308, and amount available for family living of ₱1,006. More and up-to-date information about the farm business management is needed as a basis for making suggestions for the improvement of the farmers' income under changing economic programs.

The objectives of this study were to examine the present organization, management and problems of coconut farms and to determine income on coconut farms and the factors affecting them.

Selection of the area

A number of the leading coconut provinces of the country are located in Luzon, Visayas, and Mindanao. Because of limited funds the areas of study selected were concentrated in Southern Luzon and Bicol Region. Laguna was not included because a few related studies have already been made in this area.

A total of 252 coconut farms were surveyed using a prepared questionnaire: 88 in Quezon, 82 in Camarines Sur, and 82 in Albay. These were gathered in municipalities which were arbitrarily selected relying mainly on suggestions of the provincial agriculturists. The barrios within each municipality and farmers interviewed within the barrio were selected at random.

Farmers included in this study were limited to those having at least one hectare of bearing coconuts during the 1954-55 crop year.

[2] L. S. Robertson and C. A. Bratton, *Philippine Agriculturist*, **38**, 398-404 (1954).

[3] L. S. Robertson and N. B. Tablante, *Philippine Agriculturist*, **38**, 48-56 (1954).

RESULTS

Tenure status

Tenants constituted 41 per cent of all the farmers interviewed in Quezon, 60 per cent in Camarines Sur, and 62 per cent in Albay (table 1). Owner-operators constituted 40 per cent of all the farmers interviewed in Quezon and 27 per cent of those in Albay and Camarines Sur.

TABLE 1.—*Tenure status of coconut farmers*

TENURE	ALBAY	CAMARINES SUR	QUEZON
Number of farmers	82	82	88
		percentage distribution	
Tenants	62	60	41
Part-owners	11	13	19
Full-owners	27	27	40
Total	100	100	100

Incidence of tenancy in the three provinces studied is relatively high compared to Indang, Cavite. Robertson and Tablante [4] reported that of the 132 farmers interviewed in Indang, Cavite, in 1952, only 24 farmers or 18 per cent were tenants and 65 farmers or 49 per cent were owner-operators.

Characteristics of coconut farmers

Age. The average farmer in Quezon is about four years older than the average farmer in Albay and six years older than the average farmer in Camarines Sur (table 2).

TABLE 2.—*Characteristics of coconut farmers*

CHARACTERISTIC	ALBAY	CAMARINES SUR	QUEZON
Age	46	44	50
Years of experience in farming	12	11	22
Years of schooling	3.5	4.1	3.6

Farming experience. Coconut farmers in Quezon had more experience in farming than those in Albay and Camarines Sur. Farmers in Quezon had been farming for 22 years while those in Albay and Camarines Sur had been farming for 12 and 11 years, respectively.

[4] *Ibid.*

Farmers in Quezon are generally older and most of them are owner-operators. Owner-operators stay long in farming regardless of the size of farm they operate because they feel more secure.

Educational attainment. The educational attainment of coconut farmers ranged from 3.5 years in Albay to 4.1 years in Camarines Sur. This is generally low compared to the average educational attainment of farmers as reported by von Oppenfeld *et al.*[5] They reported that the average educational attainment of farmers in the Bicol Region of which Albay and Camarines Sur are a part was 4.3 years and Southern Luzon of which Quezon is a part was 3.9 years.

The farms

Farm size. Size of coconut farms can be expressed in several ways. The most commonly used measures are total farm area, hectares cropland, hectares in coconut and number of coconut trees.

Total farm area included all cultivated land, pasture, forest, wasteland, and the farmstead. Farms were generally larger in Albay and Camarines Sur than in Quezon. The average size of farm in Albay and Camarines Sur was over six hectares compared to less than five in Quezon (table 3).

TABLE 3.—*Size of farms*

MEASURE OF SIZE	ALBAY	CAMARINES SUR	QUEZON
Farm area (hectares)	6.1	6.5	4.5
Hectares cropland	5.7	6.2	4.4
Hectares in coconut	3.9	4.3	3.8
Number of trees per farm	144	673	787

Hectares cropland is a better measure of size of farm than farm area. It includes only the area devoted to coconut production and some other crops. Not all of the farm area was devoted to crop production. The trend in terms of hectares cropland remained the same as farm area. However, it must be noted that a greater proportion of the farm area in Quezon is under cultivation compared to Albay and Camarines Sur.

Hectares in coconut which excludes cropland devoted to crops other than coconuts, is a good measure of size on specialized coconut farms. Albay and Quezon had almost the same area in coconuts.

[5] H. and J. von Oppenfeld *et al.*, *Farm management, land use and tenancy in the Philippines*, Central Experiment Station Bulletin No. 1, August, 1957.

Camarines Sur still leads Albay and Quezon in terms of hectare in coconuts.

Number of coconut trees is a measure that is also used by coconut farmers. In most cases, only the bearing trees are included. This measure of size has a disadvantage when comparing farms because of differences in distance of planting. There were more trees per farm in Quezon than in Albay and Camarines Sur. The devastation caused by the "cadang-cadang" disease and a typhoon that hit the Bicol Region before the study was made might have resulted in the fewer number of bearing trees per unit area in Albay and Camarines Sur.

Farm area by tenure. Size of farm holding by tenure of farm operator differs between Quezon and the Bicol provinces (table 4).

TABLE 4.—*Farm area by tenure*

TENURE	ALBAY	CAMARINES SUR	QUEZON
		hectares	
Tenant	5.4	5.1	3.3
Part-owner	5.4	8.1	6.2
Full-owner	8.1	8.8	4.9
All tenure	6.1	6.5	4.5

In Quezon, part-owners had the largest size of farm whereas in the Bicol provinces, owner-operators had the largest size farms. In all three provinces, tenants had the smallest size farms.

Land utilization. A greater proportion of the total cropland in Quezon was devoted to coconut production than in the Bicol provinces (table 5). Eighty-four per cent of the total cropland in Que-

TABLE 5.—*Land utilization*

LAND USE	Albay	Camarines Sur	Quezon
Hectares cropland	5.6	6.2	4.4
		per cent of hectares cropland	
Coconut plantation	70	68	84
Lowland rice	7	12	9
Other field	8	15	4
Orchard	2	1	2
Abacá	14	4	—
Total	100	100	100

zon was devoted to coconut production. Fourteen per cent of the total cropland in Albay was planted to abacá. Lowland rice and other fields comprised 27 per cent of the total cropland in Camarines Sur.

Production

The average production of nuts per hectare and per tree was highest in Quezon and lowest in Albay (table 6). The average yield of nuts per hectare in Quezon was 7,464, more than seven times as much as in Albay. In terms of nuts per tree, average production in Quezon is 3.6 times as much as in Albay.

TABLE 6.—*Production rates on coconut farms*

PROVINCE	NUTS PER HECTARE	TREES PER HECTARE	NUTS PER TREE
Albay	1,002	95	10
Camarines Sur	4,094	157	26
Quezon	7,464	207	36

The widespread destruction of the "cadang-cadang" disease might have accounted for the low yield and fewer number of bearing trees in the Bicol provinces.

Relation of number of trees to yield. Coconut farms in Quezon were grouped according to number of trees per hectare (table 7). There were mixed trends regarding the relationship of number of trees per hectare to production rates. Highest yield of nuts per hectare was obtained on farms with 200 trees per hectare. Beyond that, yield per hectare tended to decrease.

TABLE 7.—*Relation of number of trees to production rates, Quezon*

TREES PER HECTARE RANGE	MODE	NUMBER OF FARMERS	NUTS PER HECTARE	NUTS PER TREE
150 & below	150	13	6,068	43
151 – 200	200	38	7,905	42
201 & above	250	35	7,542	30
All farms		86	7,464	36

Farms with 150 trees per hectare had an average yield of 43 nuts per tree, and farms with 200 trees per hectare, 42 nuts. The lowest yield per tree was on farms with 250 trees.

This seems to indicate that a farmer starting a plantation must maintain an average of about 200 coconut trees per hectare, i.e., trees,

should be spaced about seven meters by seven meters in order to get the highest yield per hectare.

Land values

There was considerable variation in the value of land per hectare. It ranged from ₱556 in Albay to ₱1,778 in Quezon (table 8).

TABLE 8.—*Value per hectare of land and per tree*

PROVINCE	PESOS PER HECTARE	PESOS PER TREE
Albay	556	5.84
Camarines Sur	1,000	6.37
Quezon	1,778	8.59

It is also common among coconut farmers to value their farms in terms of pesos per tree. It cost about ₱6 per tree in the Bicol provinces compared to about ₱9 in Quezon.

Production rates and land values. To study the relationship between production rates and land values on coconut farms, data on 88 farms in Quezon were analyzed. The farms were grouped on the basis of number of nuts produced per hectare.

There was a positive relationship between production rates and land values. As the number of nuts produced per hectare increased, land value per hectare likewise increased (table 9). The average value per hectare of coconut farms with yields over 10,000 nuts per hectare was more than twice as much as on coconut farms with yield per hectare of 3,500 nuts and below.

TABLE 9.—*Rate of production and land values per hectare on coconut farms, Quezon*

NUTS PER HECTARE	NUMBER OF FARMS	PESOS PER HECTARE
3,500 and below	15	₱1,115
3,501 – 5,000	13	1,237
5,001 – 7,500	27	1,648
7,501 –10,000	18	2,017
Above 10,000	15	2,816
All farms	88	₱1,757

Labor input

Man days per farm. The coconut industry is generally a year round activity for the farmer. Although the work is distributed

throughout the year, however, the period between planting and harvesting leaves the farmer idle if he has no intercrop or supplementary enterprises and does not practise clean culture.

Coconut farmers in Quezon spent more days on the farm in spite of their small farms. They spent a total of 125 man days compared to 66 and 99 man days in Albay and Camarines Sur, respectively (table 10).

TABLE 10.—*Average man labor days per farm*

FIELD OPERATOR	ALBAY	CAMARINES SUR	QUEZON [a]
Total man days	67	99	125
		per cent	
Maintenance			
Cleaning plantation	44	30	37
Fencing	—	1	—
Fertilizing	[b]	—	—
Harvesting			
Picking	14	14	14
Gathering and piling	9	12	11
Husking	8	12	10
Hauling nuts	6	7	5
Copra making			
Splitting, drying, meat removing	16	21	17
Hauling copra	3	3	4
Total	100	100	100

[a] Based on two municipalities of Quezon Province (Tayabas and Gumaca).
[b] Less than one.

Cleaning the plantation as part of the maintenance chores took about 30 per cent of the total farm labor in Camarines Sur and 44 per cent of the total farm labor in Albay. In Quezon, it was about 37 per cent of the total farm labor. Very few farmers did any fencing and fertilizing on their farms.

Harvesting, picking of nuts from the tree to hauling nuts to the copra drier, took about 37 per cent of the total farm labor in Albay, 45 per cent in Camarines Sur, and 40 per cent in Quezon. Approximately 20 per cent of the total labor on the farms was spent for copra-making.

Man days per hectare. It took 30 days per hectare to maintain, harvest and prepare copra among farmers in Quezon (table 11). In Albay and Camarines Sur it took 20 and 26 days, respectively.

TABLE 11.—*Average man labor days per hectare*

FIELD OPERATION	ALBAY	CAMARINES SUR	QUEZON [a]
Maintenance			
Cleaning plantation	8	8	8
Fencing	—	[b]	—
Fertilizing	[b]	—	—
Harvesting			
Picking	3	4	5
Gathering and piling	2	3	4
Husking	1	3	3
Hauling nuts	1	2	2
Copra making			
Splitting, drying and meat removing	3	4	6
Hauling copra	1	1	2
Total	20	26	30

[a] Based on two towns of Quezon Province (Tayabas and Gumaca).
[b] Less than one.

It required more days to harvest and prepare copra from a hectare of land in Quezon because of greater number of trees per hectare and higher yields.

Labor costs per hectare. Labor cost per hectare was highest in Quezon and lowest in Albay (table 12). The average labor cost in Quezon was about four times the cost in Albay and about twice the cost in Camarines Sur.

TABLE 12.—*Average labor cost per hectare*

FIELD OPERATION	ALBAY	CAMARINES SUR	QUEZON [a]
		pesos	
Maintenance			
Clearing plantation	14	13	16
Fencing	—	[b]	—
Fertilizing	[b]	—	—
Harvesting			
Picking	4	14	26
Gathering and piling	2	5	13
Husking	2	7	16
Hauling nuts	2	3	5
Copra making			
Splitting, drying and meat removing	3	12	17
Hauling copra	1	2	11
Total	28	56	104

[a] Based on two towns of Quezon Province (Tayabas and Gumaca).
[b] Less than one.

Harvesting costs constituted the largest share of the total labor costs in Quezon and Camarines Sur. Harvesting is usually done on a contract basis. The harvesters are paid a stipulated rate in pesos per thousand nuts harvested. The lower costs of harvesting and copra drying in Albay are due to the low production per hectare.

Labor input per hectare by size of farm. The size of farm had a marked effect on the labor input per hectare. As the size of the farm increased, the labor input per hectare decreased (table 13).

TABLE 13.—*Relation of size of farm to labor input per hectare*

SIZE OF FARM	MAN LABOR DAYS PER HECTARE		
	ALBAY	CAMARINES SUR	QUEZON
1.0 – 1.9	[a]	[a]	[a]
2.0 – 2.9	32.0	31.0	41.0
3.0 – 4.9	26.9	32.1	32.0
5.0 – 9.9	18.2	30.1	25.0
10 and above	13.9	17.4	[a]
All farms	20.0	25.5	30.0

[a] Less than 10 farms represented.

Greater efficiency in the use of labor was achieved on large size farms compared to small size farms.

Sharing arrangement

Coconut plantations are usually owned by big landowners who employ tenants on their farms. The duty of the tenant ranges from starting the plantation, maintaining the plantation, intercropping, harvesting, and copra making. The share of the tenant depends on how much work he contributes.

Sharing the copra produced was most common in the three provinces studied. In Quezon and Albay, the tenant gets 46 per cent of the total copra produced and the landlord, 54 per cent (table 14). In Camarines Sur, the tenant gets about one-third of the total harvest and the landlord, about two-thirds.

On some farms in Quezon and Albay, nuts instead of copra were shared. Tenants in Albay received 67 per cent of the total harvest and tenants in Quezon, 17 per cent. In Quezon, the nuts were usually sold while still on the tree and the buyers paid for harvesting whereas in Albay the tenants did the harvesting.

TABLE 14.—*Sharing arrangements by provinces*

ITEM	ALBAY	CAMARINES SUR	QUEZON
		per cent	
Sharing copra:			
Copra (kilos)	(863)	(5,159)	(5,497)
Landlord	54	68	54
Tenant	46	32	46
By-products (pesos)	(13)	(27)	(36)
Landlord	1	15	39
Tenant	99	85	61
Sharing nuts:			
Nuts	(624)	—	(21,083)
Landlord	33	—	83
Tenant	67	—	17
By-products (pesos)	(11)	—	(28)
Tenant	100	—	100

For all farms studied, a greater proportion, if not all of the coconut by-products, goes to the tenant.

THE FARM BUSINESS

Capital investment. Capital investment per farm was highest in Quezon and lowest in Albay (table 15). A greater proportion of the capital investment per farm in the three provinces studied was tied up in fixed and semi-fixed assets. Land (including coconut trees) alone constituted about 84 per cent of the farm capital. Dwelling constituted approximately 11 per cent of the total farm capital.

Capital investment on working assets such as tools and equipment, supplies and other livestock amounted to about ₱62 in Albay and a little more than ₱120 each in Camarines Sur and Quezon.

Farmers did not fully utilize their limited resources. Very few of them raised animals other than those used for work. For instance, no farmer in Quezon raised non-work animals. Productive animals such as hogs, goats, poultry, and cattle can be raised profitably on coconut farms. Hogs and poultry can be fed with by-products of coconuts. Goats and cattle can graze under the coconut plantation and keep it clean. These animals also contribute to the maintenance of soil fertility.

TABLE 15.—*Capital investment per farm*

ITEM	ALBAY	CAMARINES SUR	QUEZON
		pesos	
Land	3,385	6,509	7,966
Work animals	135	193	218
Other livestock	6	[a]	—
Dwelling	386	872	1,119
Other buildings	9	97	50
Tools and equipments	39	93	104
Supplies	17	31	8
Total	3,980	7,795	9,465
		per cent	
Land	85	84	84
Work animals	3	2	2
Other livestock	[a]	[a]	—
Dwelling	10	11	12
Other buildings	[a]	1	1
Tools and equipments	1	1	1
Supplies	[a]	[a]	[a]
Total	100	100	100

[a] Less than one.

Farm receipts and expenses. The average farm receipts for the three provinces selected ranged from ₱249 in Albay to ₱776 in Quezon (table 16). The value of crops sold by the operators was the most important item of receipts.

MEASURES OF RETURNS

Returns from farming are best measured by the operators' farm labor earnings and family farm labor earnings. The operators' farm labor earnings refer to the returns to operator's labor and management charging labor contributed by the family and interest on capital as expenses. Family farm labor earnings refer to returns to the farm labor of the operator and members of his family.

Both measures of return were consistently high in Quezon and lowest in Camarines Sur (table 17). The average income of farmers in Quezon was a little less than four times as much as the income of farmers in Camarines Sur. Even with the comparatively high income of coconut farmers in Quezon, they may still be considered low when compared to income of other farmers. Von Oppenfeld

TABLE 16.—*Farm receipts and expenses*

ITEM	ALBAY	CAMARINES SUR	QUEZON
Receipts:			
Livestock and products sold	46	26	27
Value of harvester's share of crops	3	2	47
Crops sold by operator	200	328	702
Total	249	356	776
Expenses:			
Livestock bought	[a]	—	—
Value of harvester's share of crop	3	2	47
Buildings and tools bought	[a]	[a]	1
Cash expenses	23	48	43
Hired man labor	45	93	131
Hired animal labor	[a]	[a]	1
Value of unpaid family labor	33	24	80
Decrease in inventory	50	105	173
Total	154	272	476
Value of crops to landlord	117	668	465

[a] Less than one.

TABLE 17.—*Measures of profits on coconut farms*

ITEM	ALBAY	CAMARINES SUR	QUEZON
Net farm income	95	84	300
Interest 6% on average capital	106	231	269
Operators' labor income	–11	–147	31
Farm privileges:			
Use of dwelling	41	91	128
Livestock and livestock products	24	18	13
Rice used at home	101	66	90
Other crops used at home	81	55	67
Total	247	230	298
Operators' farm labor earnings	236	83	329
Family farm labor earnings	269	107	409
Operator's non-farm income	86	177	90
Value of unpaid family labor	33	24	80
Interest on ave. cap. invested	106	331	269
Other family non-farm income	197	93	100
Family income from all sources	658	608	868

et al.[6] reported that duck, sugar cane, vegetable and/or fruit, tobacco, and lowland palay (wet and dry) farms had operator's farm labor earnings of more than ₱400 and family farm labor earnings of more than ₱500.

The final value judgment of the family is the money available to buy the necessities in life. This is represented by the family income from all sources, farm and non-farm. The average income of farm families on coconut farms in the Bicol was about ₱600 and in Quezon, ₱869.

VARIATION IN INCOME

Income varied among farms. This is evident when farms were grouped according to location, size of farm and production rates.

Location. Farmers in Quezon earned greater returns than farmers in Albay and Camarines Sur (table 18). This has been consistent for the different measures of profits used.

TABLE 18.—*Variation in income by provinces*

PROVINCE	NUTS PER HECTARE	% SHARE OF TENANT	FARM LABOR EARNINGS		FAMILY INCOME FROM ALL SOURCES
			Operator	Family	
Quezon	7,464	46	329	409	868
Albay	1,002	46	236	269	658
Camarines Sur	4,094	36	83	107	608

The greater profits of farmers in Quezon was due mainly to high production rates on their farms. Production rates in the Bicol were considerably low due to the effects of typhoons and the "cadang-cadang" disease of coconut.

In the Bicol, however, it took more than mere production rates to increase the income of the farmers. The shares of the tenant were much lower in Camarines Sur than in Albay.

Size of farm. Income increased with each increase in size of farm (table 19). The trend was fairly consistent with regards to family income from all sources. Inconsistency in the other measures was due mainly to the extreme variation in income in Camarines Sur.

Labor costs constitute about half of the total farm expenses on coconut farms. Because labor is more efficiently utilized on large

[6] *Ibid.*

TABLE 19.—*Farm size and income*

SIZE OF FARMS	MAN DAYS PER HECTARE	FARM LABOR EARNINGS		FAMILY INCOME FROM ALL SOURCES
		Operator	Family	
1.0 – 1.9	37	105	116	413
2.0 – 2.9	36	80	114	494
3.0 – 4.9	29	229	262	591
5.0 – 9.9	23	416	512	897
10.0 and above	17	56	132	1,369
All farms	24	216	266	717

farms, the labor cost per unit area decreases as the size of the farm increases. This results in greater income accruing to farmers on larger farms.

Production rates. Yield of nuts per hectare is as important if not more important than the size of farm in effecting profits. Only data for Quezon is presented due to the unfavorable conditions existing in the Bicol.

Increases in yield were consistently reflected in income (table 20). High production rates within a farming area is a reflection of fertile soil and good management. Although this may mean high total interest charge on capital investment and higher labor costs, the increased yields more than offset the added costs.

TABLE 20.—*Production rates and income, Quezon*

NUTS PER HECTARE	NUMBER OF FARMS	FARM LABOR EARNINGS		FAMILY INCOME FROM ALL SOURCES
		Operator	Family	
3,500 & below	14	–184	–115	327
3,501 – 5,000	14	365	450	800
5,001 – 7,500	27	289	426	935
7,501 – 10,000	18	510	555	961
Above 10,000	15	632	665	1,242
All farms	88	329	409	868

SUMMARY AND CONCLUSIONS

The income of the coconut farmer is generally low. This should not be viewed as a static return incapable of being increased. There are tremendous possibilities of increasing the income of coconut farmers.

The coconut farmer works from 67 to 125 days on coconuts per farm in a year. As there may be limited opportunities from off-farm employment, the farmer must utilize available materials and resources in the farm to increase his total income. Broom-making out of coconut leaves, gathering coconut leafstalks for firewood and charcoal making out of coconut shells are some possibilities.

The farmer can plant additional cash crops such as pineapple, coffee, lanzones, bananas, and root crops. Whenever possible, livestock raising may well fit in the organization and operation of coconut farms. Livestock as pigs, cattle, goats, or poultry may bring in additional income, help keep the plantation clean, and contribute to maintenance of soil fertility.

The sharing arrangements on coconut farms depend on the amount of work contributed by the tenant. The practice of selling the nuts while still on the tree may seem convenient but should be minimized. The farmer must do more of harvesting the nuts and copra drying. What would otherwise go to the harvesters should accrue to the farmer.